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SURGERY

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THE TREATMENT OF STAPHYLOCOCCUS SEPTICEMIA WITH BACTERIOPHAGE

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REPORTS of the use of bacteriophage in cases of *Staphylococcus aureus* septicemia in recent years are encouraging. Unfortunately, the small number of cases treated with bacteriophage, and the lack of controls in most of the series heretofore reported, make it difficult to draw definite conclusions. In this paper we are reporting a series of 36 unselected and consecutive cases of *Staphylococcus aureus* septicemia treated with bacteriophage and comparing it with a series of 54 unselected cases over a 10 year period which were not treated with bacteriophage.

In 1925, Lawson reported a series of 38 cases of hemolytic *Staphylococcus aureus* septicemia with 31 deaths, a mortality of 80 per cent. In 1936, Scott reported 68 cases of hemolytic *Staphylococcus aureus* septicemia, 8 of which received bacteriophage. The 60 patients who did not receive bacteriophage were treated with one of the following agents intravenously: colloidal solution of iodine, metaphen, arsphenamine, gentian violet, and acriflavine. There were 49 deaths, a mortality of 81.6 per cent in this group of 60 patients, while in the group of 8 patients who had bacteriophage, there were only 4 deaths involving a 50 per cent

mortality. This is a small series, but perhaps a significant figure. In 1932, MacNeal and Frisbee (4) reported 15 cases of patients who received bacteriophage, with 8 deaths. As one of these patients died long after the blood culture had been repeatedly negative, it may be omitted in computing the mortality of 50 per cent. In 1936, these authors (6) reported another series of 100 cases treated with bacteriophage prepared in their laboratory, although many of the patients were not seen by them nor were they under their immediate control. There were 75 deaths or a 75 per cent mortality. In 1933, Dutton reported 12 cases in which patients were treated with bacteriophage. As he states that 5 of these cases may not have been true septicemia, they have been omitted in calculating the mortality of 14.2 per cent, or 1 out of 7 cases. There are additional reports of single cases throughout the literature. These are of little value and will not be discussed.

In none of these series is there any specific data as to the potency of the bacteriophage. MacNeal and Frisbee (5) mention that it is important to use a phage which is potent against the organism causing the infection. However, their criterion of potency is the ability of the phage to clear or lyse the culture of the organism in liquid media.

From the Bacteriological Research Laboratory of the Department of Surgery, College of Physicians and Surgeons, Columbia University, and the Surgical Service of the Presbyterian Hospital.

We were first encouraged to make a comprehensive study of bacteriophage therapy in staphylococcus septicemia by the successful demonstration by Dr. MacNeal of its use in a desperately sick patient in the Presbyterian Hospital in 1932. During the succeeding 6 years one or more of the members of our staff in the Bacteriological Research Laboratory of the Department of Surgery of the Presbyterian Hospital have seen and treated the 36 patients whose cases are included in this report.

As the clinical features of cases of Staphylococcus aureus septicemia are well known those found in this series will be only briefly mentioned. Every one of these cases fulfilled our criteria of septicemia, namely the typical clinical picture plus a positive blood culture. They all had the usual high spiking temperature with leucocytosis, except in 1 case of aleucemic leucemia. In every instance the patient was desperately ill when first seen by us. The portal of entry for the organism in these cases is greatly diverse and in some cases entirely unknown.

TREATMENT

The treatment in this series is divided into 3 parts (a) local (b) systemic or supportive and (c) intravenous bacteriophage.

In a recent paper on septicemia, one of us emphasized the responsibility of the surgeon to find and approach the focus of infection as soon as a positive blood culture is obtained. The continual seeding of the internal organs puts a tremendous load on their bactericidal function and the longer it is maintained, the more likelihood there is of establishing metastases which cannot be reached. This principle of finding and draining the distributing focus whenever possible was followed both in the phage treated cases and in the control series.

The local treatment consisted in finding and opening widely localized foci to insure adequate drainage. In addition to drainage the wounds in this series were irrigated daily with saline and bacteriophage applied freely to all parts of the wound, either with a single daily dressing of a pack of fine mesh gauze saturated with bacteriophage, or by delivering it through Carrel Dakin tubes which had been placed into the wound and brought out under the dressing.

The systemic treatment in these cases consisted of the usual supportive measures used in overwhelming infections. In our series, transfusions were given for definite indications only such as progressive anemia, low serum protein or some other abnormality of the blood chemistry. In a study of reported cases we find no real evidence that transfusions carry over any immune substances for staphylococci from the donor to the patient. When anemia occurs, however, the addition of red cells is important.

In giving the bacteriophage intravenously the following procedure was carried out in most of the cases. As soon as a positive blood culture had been reported to us, the organism was immediately tested for susceptibility to our stock bacteriophage. However as this often requires 36 to 48 hours and since tests have proved that about 95 per cent of the staphylococcus organisms which we have recovered from various acute lesions in humans are susceptible to one or more of our stock bacteriophages, we do not delay treatment until this report is ready but start the intravenous therapy with one of the stock phages.

In order to minimize any reaction we give our first day's treatment in divided doses over a 7 hour period as follows. Starting with 0.1 cubic centimeter in 1 cubic centimeter saline, the phage is given in increasing doses at intervals of 1 hour in the following amounts: 0.1 0.25 0.5 1 2 3 and 4 cubic centimeters diluted to 10 times in normal saline. If at any stage there is a reaction the injections are stopped and resumed after 8 hours with the next smaller dose than the one which produced the reaction. If reactions occur further increasing of the dose must be done very cautiously as it is probably best to keep the daily dose below that one which produces a constant reaction. If there is no reaction to the series of injections given the first day 5 cubic centimeters are given the next morning and 10 cubic centimeters in the afternoon. The dose is then cautiously increased by 5 cubic centimeters for each injection until the patient is receiving 50 cubic centimeters a day or until the blood culture is negative and the temperature normal. If the desired result is not obtained with the dose of 50 cubic centi-

meters a day, it can be increased gradually to 100 cubic centimeters daily. In some cases it is better to give the larger quantities in 2 divided doses at 8 to 12 hour intervals. However, we have on occasion given the larger amounts in single doses without any untoward effects. The preceding outline of the method of administering intravenous bacteriophage was employed in most of our cases. However, in patients acutely ill, with high colony counts in the blood culture, or with evidence of involvement of the internal viscera such as lungs, kidneys, or pleura, we often were forced to increase the size of the dose more rapidly.

In our early experiences with bacteriophage we used relatively small doses and were not as certain of its potency as we have been in recent years. We have, therefore, divided the cases treated with bacteriophage into 2 groups: those treated before October, 1936, and those treated for the 2 years after that date. At this time we not only increased the amounts given, but we put our criterion for the potency of our phage on a much sounder basis.

DOUBLE POTENCY TEST

In 1935, two of us, Jern and Meleney, described a new method for testing the potency of bacteriophage. Our previous criterion for potency was simply complete visible lysis in our savita broth cultures. Tubes showing 4 plus lysis were filtered and the phage used. However, when a loopful from these tubes was plated on 5 per cent sheep's blood agar, it was frequently found that growth would develop on the blood agar plates, showing that the organisms were not completely killed by the lytic process. Now the organism is first tested in the usual manner in a liquid medium, savita broth. We have found savita broth, which is low in protein content, much more favorable than asparagin as a culture medium for bacteriophage and more effective clinically. The tubes are incubated for 24 hours, after which all cultures showing complete clearing or 4 plus lysis are reinoculated on sheep's blood agar plates. These plates are then incubated for 24 hours. It is necessary for them to show no growth before we consider the organism completely susceptible to our phage. Thus the potency of the phage is demon-

TABLE I —RESULTS OF POTENCY TESTS

Lysis in savita	Growth on plate 5 per cent sheep's blood	No. of patients	No. of deaths	No. of survivals	Mortality per cent
4+	4+	21	5	16	23.8
4+	1+ to 3+ growth	5	4	1	80
4+	not plated	8	6	2	75
2+	—	1	1	—	100
0	—	1	1	—	100
		36	17	19	47.2

4+ = complete lysis 1+ to 3+ = partial lysis.

strated not only in the broth, but also on the blood agar plate. If there is complete, or a 4 plus lysis in the tube and no growth, or a 4 plus on the plate, we call it "double potency" phage.

ANALYSIS OF RESULTS

The results of the potency tests in these cases are clearly illustrated in Table I. As there were only 7 cases of the 15 in the early group, in which the plate test for potency was run, the results of this test have been summarized as a whole.

There were 21 cases in the entire series which gave a 4 plus tube test and a 4 plus plate test. Of this group 16 patients survived and 5 died, a mortality of only 23.8 per cent. In the group of 13 cases which gave a 4 plus lysis in the tube and either less than a 4 plus plate test or were not tested at all, there were 10 deaths, and 3 survivals, or a mortality of 76.9 per cent. If, on the other hand, we consider the small group of 5 cases which gave a 4 plus tube test and less than 4 plus plate test, we find the mortality to be 80 per cent. The case which showed only a 2 plus lysis in the tube and the remaining case in which phage was given but was found to produce no lysis in the tube each had a fatal outcome.

There can be little doubt in those cases in which the test on the plate showed no growth, that the clinical results were considerably better than in the other cases. In the former, we know that we were using the most potent phage which could be produced against the organism infecting the individual. In the latter, the phage may or may not have been the most potent that could be produced against the organisms in question.

TABLE II.—DOSE OF BACTERIOPHAGE*

	Smallest dose, cm		Largest dose, cm		Average 24 hour dose, ccm
	24 hour	Total	24 hour	Total	
Oct. 1 to Oct. 1936 Survivors Fatalities	1 95	30 1	20 24	24 24	5 to 10
Oct. 1 to Oct. 1936 Survivors Fatalities	10 10	90 10	170 20	180 20	20 to 30

*Data incomplete in few cases not included

We have found it practically impossible to estimate accurately the duration of the sepsis before bacteriophage was given. Many of the cases, both among the survivors and the fatalities, had symptoms which indicated bacterial invasion 10 or more days before the administration of bacteriophage. Nine of the 19 survivors, or 47 per cent, had positive blood cultures for at least 3 days before receiving treatment, while in the group of 17 patients who died 12 or 71 per cent, were known to have had a positive blood culture for at least 3 days before starting bacteriophage. There seems to be little doubt that the longer virulent organisms persist in the blood stream, the more likely they are to develop secondary abscesses in the viscera. Consequently the importance of early and persistent administration of phage in cases of staphylococcus septicemia cannot be too strongly emphasized.

Prior to October 1936 our dose of phage had been what we now consider very inadequate both in the amount and in the potency of the phage administered. As previously mentioned, there were 7 cases in the early group of cases which received our double potency phage. However, the quantity given was very small and probably insufficient. In the late group not only were larger doses given, but every patient received the double potency phage. Table II shows the doses of phage used in these 2 series.

It is seen at once that in both groups the survivors received more phage than the fatal cases. In the early group of cases, with one exception, the maximum daily dose was only 35 cubic centimeters with an average daily dose of only 5 cubic centimeters, and the total maximum amount given to any one patient was 205 cubic centimeters. The exception in

TABLE III.—SITES OF METASTATIC ABSCESES

	Early series No. of survivors	No. of deaths	Late series No. of survivors	No. of deaths
Bones			6	
Lungs		5		4
Liver		3		1
Kidney		4		1
Heart		3		
Pleura				
Subcutaneous Joints			3	
Pericardium				
Endocardium				
Cavernous sinus				
Phlebitis				
Psoas muscle				
Spleen				
Pancreas				
Thyroid				
None found	3		4	

this group of cases received 40 cubic centimeter doses and a total amount of 536 cubic centimeters. It is also an interesting fact that this is the one case in which the patient had more than 6 positive blood cultures after starting phage and is one of the 4 survivors in this group.

Subsequent to October 1936 we began giving larger doses of phage. In this group there are 21 patients. The maximum amount given any one patient in a 24 hour period was 370 with a total amount administered in a single case of 2 520 cubic centimeters. The average daily adult dose was about 50 cubic centimeters varying according to the condition of the patient and the persistence of the positive blood cultures. In some cases we have found it advantageous to continue with intravenous phage for 5 to 10 days after the blood culture has become negative.

Many of our cases showed metastatic lesions. Table III lists these metastatic foci as found. It can be seen that the cases with metastases in the viscera carry a much higher mortality rate than do those with the secondary lesions in the bones and joints. It is also interesting to note that in the group of early cases only one patient with a known metastasis survived while in the later group metastases were found in all but 4 patients, leaving at least 11 with metastases who survived. The significance of these figures becomes apparent when one realizes that in 14 of the 17

deaths, metastases of the viscera were found either at autopsy or operation. It stands to reason that if seeding of these organs had been prevented or stopped earlier, these abscesses would have been less likely to occur. It is our belief that bacteriophage given intravenously plays an important part in preventing these metastases. If this is so important, the necessity of starting early vigorous treatment with bacteriophage cannot be overemphasized.

The time of seeding of the internal organs with subsequent abscess formation may take place early in the course of the disease. This point is clearly illustrated by 4 patients in this series who died within 8 days after the onset of the first symptoms. All of these cases came to autopsy. Abscesses were found in the lungs, liver, and kidneys of all. In some, metastases were also found in the spleen, thyroid, pancreas, and endocardium. However, there are cases with a known sepsis of considerably longer duration which either never developed these abscesses or they subsequently cleared. As it is impossible to predict which patient will and which one will not develop these abscesses early, it seems advisable to institute bacteriophage therapy at an early stage so as to minimize this possibility. The fact assumes an added importance when one realizes that all of the 11 cases which came to autopsy showed metastases in the viscera. In 4 of the remaining 6 fatal cases which did not come to autopsy, abscesses were found in the subcutaneous tissue, bone, joints, or muscle, either at operation or by aspiration. In the other 2 cases which did not come to autopsy no metastases were clinically demonstrable. The 100 per cent incidence of visceral metastases in all 11 of the cases, which were examined post-mortem, makes it reasonable to suppose that most, if not all, of the cases not examined, also had visceral metastases. It is our belief that once these visceral metastases have been well established the prospect of recovery is greatly prejudiced.

It seems to be more difficult for staphylococci to gain a foothold in certain organs and tissues of the body than in others, and we assume that the resistant organs or tissues have some defense mechanism against the organism. But even in resistant tissues the defense may be

TABLE IV—SUMMARY OF FINAL RESULTS

Time of treatment	No. of cases	No. of survivals	No. of deaths	Mortality per cent
Before Oct., 1936	15	4	11	73.3
Oct., 1936 to Oct., 1938	21	15	6	28.5
Total	36	19	17	47.2
Controls	54	10	44	81.4

broken down by an overwhelming seeding of virulent organisms. Anything which can diminish this seeding will minimize the number of metastatic foci. The mechanism of bacteriophage action has not been clearly demonstrated. MacNeal believes that its chief actions are to stimulate leucocytosis and to render the organisms more susceptible to phagocytosis. We have some indication also that it directly destroys or injures organisms in the blood stream. This evidence will be presented in a subsequent publication.

Table IV summarizes the results of the entire series, dividing the cases into the 2 groups which have been described previously. In the group of 15 early cases there were 11 deaths, a mortality of 73.3 per cent, while in the later group of 21 cases, there were only 6 deaths, a mortality of only 28.5 per cent. In the entire series of 36 cases, the mortality was 47.2 per cent or 17 deaths. These figures are considerably lower than we have been able to find in the literature, even for cases which were treated in a similar manner, except for Dutton's small series. When these are compared with our control series of 54 patients with 44 deaths, or a mortality of 81.4 per cent, the contrast is quite striking. It leaves no doubt in our minds that those patients who received bacteriophage fared better than those who did not have the advantages of this therapeutic agent.

ANALYSIS OF FAILURES

A review of our 17 unsuccessful cases brings out some interesting points which show the importance not only of establishing the diagnosis early in cases of staphylococcus septicemia, but also of starting bacteriophage as soon as the diagnosis has been made. In some cases it will be necessary to take daily blood cultures in clinically suspicious cases if the diagnosis is to be made at the earliest possible moment. In 26 of our cases there was a delay of 10 or more days between the onset of the

first symptoms of sepsis and the taking of the first blood culture. In 22 cases 3 or more days elapsed between the first positive culture and the starting of intravenous phage.

Either as a result of this delay or due to the overwhelming nature of the infection 7 of the 17 fatal cases were semicomatose and practically moribund when they first received bacteriophage. None of these cases showed the slightest response to the treatment and all of the 7 patients died within 24 hours after the first dose. There were 4 patients who died between the first and sixth day after starting phage. Three of these were in the earlier group of cases and not only received small doses of phage but phage of lower potency than that given in the later series. The 6 remaining fatal cases all survived 6 or more days after the initiation of the phage therapy before succumbing to their infection. All but 1 of these last 6 cases belong to the earlier group. Of the 6 deaths in the later group 4 occurred within 24 hours after the first dose of phage 1 lived 3 days, and the other died on the fifteenth day. It will be of interest briefly to summarize these 6 fatalities in the large dose-high potency group.

CASE HISTORIES

CASE E.M., aged 35 years, female white. The patient was admitted January 13, 1937 to the Institute of Ophthalmology with a day history of cellulitis of the upper lid of right eye. The abscess was incised and drained on the day of admission. Blood culture January 4 revealed hemolytic *Staphylococcus aureus*. The patient was given 54 cubic centimeters of bacteriophage intravenously on the night of January 5. She was acutely ill and semicomatose at this time. On the morning of January 6 definite signs of bilateral cavernous sinus thrombosis with meningitis were present. Continuous infusion of bacteriophage was started. Temperature rose to 103.6 degrees and then fell to 101.3 degrees in the afternoon. However, in spite of vigorous supportive treatment the course was progressively downhill and she died on January 16 exactly 3 days after the onset of first symptoms.

The principal postmortem findings were acute suppurative panophthalmitis, bilateral bilateral acute suppurative thrombophlebitis of cavernous sinuses and internal jugular veins, acute suppurative leptomenigitis, abscesses of lung, heart, and liver, acute splenic tumor and lobular pneumonia.

This was an unfortunate case of bilateral cavernous sinus thrombosis, resulting from an

infection in a dangerous area of the face. This patient received bacteriophage early in the course of the disease and promptly after the first blood culture. The rapidity of the process suggests that the unusually virulent organism in a particularly vulnerable spot in a susceptible patient made the outcome inevitable.

CASE 2 H.H. aged 5 years, white, male. The patient was admitted to the urological service of Presbyterian Hospital January 2, 1937 for persistent fistula at the lower angle of the suprapubic wound, following prostatectomy on November 9, 1936. He was cystoscoped with difficulty on January 23, 1937. No reaction took place until January 24 at which time he had elevation of temperature to 104 degrees. Temperature continued elevated spiking through 101 and 103 degrees throughout the remainder of life. Blood culture on January 30 showed hemolytic *Staphylococcus aureus*. An indwelling catheter was inserted. The patient was given transfusion, 250 cubic centimeters of whole blood on February 1 and February 3. His course rapidly became worse and the patient was practically moribund on February 4, when he received 50 cubic centimeters of bacteriophage in 500 cubic centimeters of normal saline intravenously. Pulse and temperature fell but the clinical picture did not change and the patient expired on February 5.

The principal autopsy findings in this case were: Bilateral acute and chronic pyelonephritis, false passage of urethra, acute bacterial endocarditis, tricuspid valve, pulmonary embolism (infected), bilateral bilateral infarcts of lungs (infected), abscesses of kidneys, bilateral thrombophlebitis of pelvic veins.

This was a distressing case developing on the wards following a cystoscopic examination. There was a delay of 6 days after onset of first symptoms of sepsis before a blood culture was taken, plus a delay of 5 days after first positive culture before the patient received bacteriophage. The entire duration of sepsis was probably about 12 days with early appearance of metastatic lesions. The delay in diagnosis plus the delay in the use of phage may have played a rôle in the outcome of this case; the patient promptly developed an endocarditis.

CASE 3 S., colored, male. The patient was admitted to the surgical wards at St. Luke's Hospital with carbuncle on back of neck. Following incision and drainage the course was entirely satisfactory and the wound healed. On the day before he was to be discharged he had a chill. Blood culture at that time showed hemolytic *Staphylococcus aureus*. He was given 4 to 3.6 grams of sulfanilamide daily during the next 3 to 4 days. This had no noticeable effect on the clinical course or number of colonies of sta-

phyllococcus per cubic centimeter of blood. During the next 10 to 12 days he was given relatively large amounts of bacteriophage intravenously. This was prepared in another laboratory and the potency is not known. His course was slowly downhill with a persistent high colony count in the blood stream. Twenty-four hours before exodus he was given 50 cubic centimeters of bacteriophage prepared in our laboratory. At this time he was semicomatose, cyanotic, and the pulse was rapid and feeble. The blood culture taken subsequently showed a marked reduction in the colony count. Eighteen hours later his chest was tapped and 750 cubic centimeters of dirty, straw-colored fluid was removed, 10 to 20 cubic centimeters of phage were instilled in the pleural cavity and 50 cubic centimeters more given intravenously. His course continued downhill and just before exodus he was given an additional 50 cubic centimeters of phage intravenously.

The principal necropsy findings in this case were bilateral lung abscesses, abscesses of heart and liver, empyema, bilateral kidney abscesses.

This was an unusual case, developing sepsis late in the course of healing of a carbuncle. It is most likely that he had a bacteremia early in the course of the disease with the establishment of one or more visceral metastases which then began to distribute foci, causing the fatal sepsis after the original local lesion was practically healed. In this case the several days' delay caused by using sulfanilamide, which we now believe is of no value in infections caused by the staphylococcus group of organisms, probably was significant. However, the evidence suggests that metastases were already present at the time of the first positive blood culture. The marked diminution in the colony count in this case after the use of our "double potency" phage suggests that dissemination of the organism might have been prevented if it had been administered earlier.

CASE 4. J C, aged 26 years, male, white, was admitted February 10, 1938, to metabolism wards on the medical service of the Presbyterian Hospital for diabetes. During the preceding 2 weeks he had had several shaking chills and a constant pain in the left flank. He was transferred to the urological service February 15, 1938, and a left perinephric abscess was opened and drained on February 16. In spite of drainage of the abscess, he continued to run a spiking fever with temperature ranging between 100 and 104 degrees. During this time he gradually developed pain in the right flank and a mass was felt in the region of right kidney. Because of a persistent septic temperature, a blood culture was taken on March 18, about 49 days after his first chill. Intravenous bacteriophage was started on March 21,

with an initial dose of 40 cubic centimeters given in divided doses over a period of 5 hours. During the next 10 days he received the following amounts of phage. From March 22 to March 25, inclusive, he was given 25 cubic centimeters, 4 times a day. On March 26, 27, 28, 29, 31, April 1, and April 2 he received 60, 70, 40, 50, 75, 100, and 100 cubic centimeters, respectively, 4 times a day. On March 24 a right nephrotomy was done, multiple carbuncles being found in the right kidney, and the wound was packed open. Phage was used in both the right and the left wounds as well as given intravenously. Blood cultures taken during this illness were all positive for hemolytic *Staphylococcus aureus*. His course was progressively downhill and he expired on April 2, 1938.

The principal pathological findings at autopsy in this case were furuncles of forehead, abscesses of myocardium, lungs, and adrenals, perinephritic abscesses, bilateral, acute fibrinopurulent peritonitis (localized), diabetes mellitus, tuberculosis of lungs.

This was a case of hemolytic *Staphylococcus aureus* septicemia in a known diabetic with metastatic foci developing first in the left and then in the right kidney. The sepsis as far as one can judge from the clinical picture began at least 46 days before a blood culture was taken. Intravenous bacteriophage was not started until 3 days later, when there was clinical evidence of metastatic lesions in the opposite kidney but operation was delayed. Under these circumstances, in spite of large doses of our double potency phage, the course was downhill and the patient expired 15 days later. During the last 10 days of this boy's illness it was practically impossible to control his diabetes. The delayed diagnosis of septicemia, the delayed operation, and the delayed administration of bacteriophage, all probably played a part in the fatal outcome, but the underlying diabetes and the extensive visceral metastases, which probably developed early, may have rendered the outcome inevitable.

CASE 5. M B, aged 3 years, female, was admitted September 29, 1936, with the diagnosis of lymphoblastic leukemia. There was a vague history of infection during the preceding month. Blood cultures September 29, 1936, revealed *Staphylococcus aureus*. Two subsequent blood cultures on October 1 and October 3 were also positive. No focus of infection was found. White blood count on admission was 2,500, polymorphonuclears, 49 per cent, lymphocytes, 43 per cent, myelocytes, 7 per cent. On October 5 the patient was given 10 cubic centimeters of bacteriophage intravenously. Even though the patient lived until October 7, she was not given any more phage.

The principal autopsy findings were abscesses in liver, heart, kidneys, and lungs. Infarcts of spleen and liver thrombi (infected) in hepatic and splenic veins, lobular pneumonia, jaundice due to obstruction of common bile duct from outside pressure.

This case represents a severe terminal infection in a case of leucemia during an aleuemic phase. The result was not unexpected and could hardly have been prevented.

CASE 6. R.S., aged 39 years, female, as admitted to a suburban hospital January 24, 1935, for carbuncle of 5 days' duration. Three days prior to her admission she began to have shaking chills and was known to be running an elevated temperature, but no blood culture was taken. The carbuncle was incised and drained on January 24, and the patient discharged on January 26. The day after her discharge she was readmitted for pain in her right flank. At this time her temperature was 105 degrees and her pulse rate 140. She was acutely ill and had signs pointing toward an infection of her right kidney. Cystoscopic examination on January 28 was negative. Blood culture on January 29 revealed hemolytic *Staphylococcus aureus*. She was seen by one of us, F.L.B., and intravenous bacteriophage was recommended but postponed. The kidney was explored on January 30 and found to contain multiple carbuncles. These were incised and drained. The culture of the wound showed hemolytic *Staphylococcus aureus*. Bacteriophage was introduced into the drainage tube daily. A second blood culture on January 31 before giving intravenous phage showed approximately 400 colonies of hemolytic *Staphylococcus aureus* per cubic centimeter. On January 31 the patient was given 18.75 cubic centimeters of phage intravenously in gradually increased doses, and on February 1 she received 65 cubic centimeters more divided in 3 doses. However in spite of transfusions and other supplementary supportive therapy the course was progressively downhill and she died on February 19, 1935. Blood culture on February 19 showed 700 colonies per cubic centimeter.

The autopsy findings were limited to the kidney and lungs, both of which showed multiple abscesses.

In all probability the onset of sepsis in this case occurred 3 days before her first admission. This was not recognized until her second admission and 8 days after the onset of her carbuncle when she already had metastatic abscesses in her right kidney. There was an additional delay of 3 days before the blood culture revealed the staphylococcus and a total of 10 days elapsed between the onset of her symptoms of sepsis and the starting of intravenous bacteriophage. The diagnosis of septicemia might have been made earlier and

bacteriophage administered earlier. However the rapid development of visceral metastases rendered prognosis in any event extremely bad.

HISTORIES IN 6 SUCCESSFUL CASES

In contrast with the summaries of the 6 fatalities of the later group the following successful cases are reported as examples of patients in whom the bacteriophage played an important if not essential rôle in recovery. These 6 cases are selected also because they illustrate different phases of this disease.

CASE 1. L.B. aged 39 years, female, was admitted to the gynecological service of Sloan Hospital for a myomectomy which was performed on September 30, 1936. After operation she ran stormy course with temperature spiking between 1 and 35 degrees. This was associated with some swelling and redness of her wound. On October 1 she had a shaking chill. Blood cultures taken during chill revealed hemolytic *Staphylococcus aureus* as did culture taken at the lower angle of her wound. The wound was then spread slightly at its upper and lower poles and through-and-through drains were placed. 1 split of transfusions and the usual supportive treatment her course was progressively downhill over a period of 20 days, during the last 3 of which she was irrational and at times semiconscious, and she was expected to die. Five blood cultures were taken during this period and all were positive. On October 30 she was given 50 cubic centimeters of bacteriophage intravenously in one dose. A blood culture taken just before starting phage was positive. Twenty-four hours later another culture taken just before the second dose of 50 cubic centimeters of phage was negative. All cultures subsequent to this date are negative. In spite of marked improvement in her general condition she continued to run temperature daily between normal and 10 degrees. She was therefore given an additional 50 cubic centimeters of phage on October 26, 1936. Examination then revealed a pelvic abscess, which later ruptured spontaneously into the wound. Following this the course was uneventful, and the patient was discharged completely healed. The wound was dressed with daily irrigation and instillations of bacteriophage.

This is a brilliant result in a postoperative infection with subsequent sepsis. The patient's life was despaired of before the phage was started. The immediate disappearance of organisms from the blood stream after the first dose was dramatic, but hardly less so than the patient's clinical response once her sepsis was under control. It illustrates that the phage may be given in large initial amounts to patients who are critically ill.

CASE 2 S D, aged 35 years, colored, male, was admitted to the surgical wards of the Presbyterian Hospital on March 14, 1937, with a diagnosis of prolapsed and ulcerating hemorrhoids. Nine days prior to admission he began to have pain in his rectum, and 7 days before admission he had a shaking chill. On admission his temperature was 102 degrees. Examination showed large protruding ulcerated hemorrhoids. Blood cultures on March 16 and March 18 revealed hemolytic *Staphylococcus aureus*. Rectal examination showed a large edematous and indurated seminal vesicle on the right. This was opened and drained through a perineal incision. The operation was thought to establish inadequate drainage. Bacteriophage was started on March 19, intravenously and also applied locally. The blood cultures remained positive 16 days after starting phage. The patient made an uneventful recovery and was discharged. Subsequently he was readmitted on 2 occasions for drainage of 2 Brodie abscesses of his right tibia. These also revealed hemolytic *Staphylococcus aureus* and probably represent delayed appearance of metastatic abscesses. They were treated locally with bacteriophage and promptly healed.

This is an interesting case of septicemia in a colored male. The distributing focus on admission was the right seminal vesicle. He had his first symptom of sepsis 7 days prior to admission and 13 days before receiving bacteriophage. In view of the long duration of his sepsis it was surprising that he did not develop demonstrable foci in some of his viscera. The second blood culture before phage was given revealed the presence of a spontaneous bacteriophage which may have inhibited the growth of organisms in his blood and minimized the establishment of metastatic foci. It did not, however, prevent the growth of organisms when his blood was transferred to artificial media. The phenomenon of the spontaneous appearance of bacteriophage, which we have observed in one other case, is being studied and will be reported in a subsequent paper.

CASE 3 E V, aged 54, male, was admitted to a suburban hospital April 5, 1937, for an alveolar abscess. Two weeks before admission he began to have pain and swelling in his nose. The involved area was drained, but he continued to have fever, headaches, and generalized body pains. Temperature on admission was 102 to 104 degrees. The mucous membranes covering hard palate and gums were swollen and red and pus was draining from the upper gum margin. Blood culture on April 5 revealed hemolytic *Staphylococcus aureus*. He was given one

dose of prontosil. It was discontinued and over the next 3 days he received alcohol 10 per cent infusions. Bacteriophage was started on April 8. At this time he had definite evidence of fluid in his right chest. This was tapped April 8, and a dirty yellow cloudy fluid was withdrawn, which yielded the organism. Ten cubic centimeters of phage was introduced into the pleural cavity. During the next 20 days he received 16 intravenous injections of 50 cubic centimeters of bacteriophage. Bacteriophage was also applied locally to the gum area. The last positive blood culture was obtained on April 14, 1937, or 5 days after the first dose of phage. The patient then proceeded to make an uneventful recovery.

When first seen by us, this patient was very ill with metastatic lesions in the lung and pleura. The fluid aspirated on April 8, 1937, was the only fluid obtained from the chest. There was no evidence of a reaccumulation. It is another example of a recovery from a case of hemolytic *Staphylococcus aureus* sepsis in a patient who was desperately ill at the time bacteriophage was started.

CASE 4 F P, aged 8 months, male, was admitted to Babies Hospital June 1, 1937, with a diagnosis of acute osteomyelitis of right tibia and cellulitis of the great right toe. Ten days prior to admission he had contracted an upper respiratory infection. This was followed by a cellulitis with threatening gangrene of his toe. Temperature on admission was 105 degrees. Blood culture on June 2 revealed hemolytic *Staphylococcus aureus*. Intravenous bacteriophage was started on June 4, 2 days after the first positive blood cultures. During the course of the next 20 days he received a total of 125 cubic centimeters of bacteriophage intravenously. Blood cultures on June 13 and June 18 were positive. Subsequent blood cultures were all negative. Intravenous bacteriophage was continued for 6 days after his last positive blood culture. During the course of phage therapy the osteomyelitis of his right tibia was incised and drained on June 11. The following metastatic abscesses later developed and were also drained: June 25, right humerus, July 9, prepatellar bursa, February 16, 1938, carpal bones of right wrist, March 8, scalp, March 24, right arm and chest wall. Upon discharge from the hospital he had a small sinus over the tibial wound. This healed promptly. Phage was also applied to local lesions. The patient was seen at frequent intervals and had to be readmitted in September, 1938, with abscesses of occiput and right zygoma. These were incised and drained and healed promptly.

This case illustrates a hematogenous osteomyelitis with septicemia in an infant. The patient was desperately ill on his first admission and little hope of recovery was antici-

pated. His sepsis persisted 14 days after bacteriophage was started. There was at no time evidence of pulmonary or renal involvement. Metastatic lesions developed in tissues which could be reached surgically. The successful outcome of this disease in an infant is very rare. There are only 3 recoveries in the group of 24 children, who did not receive bacteriophage, a mortality of 87.5 per cent. In the series which received phage there are 11 cases in children with 4 deaths giving a 36.3 per cent mortality. In the late group of this series there were 6 cases of acute osteomyelitis with septicemia in children with no fatalities. Consequently we are of the opinion that in children with this type of septicemia, associated with an acute osteomyelitis we can offer a fairly good prognosis if they receive intravenous bacteriophage early in the course of the disease.

CASE 5 N.R., red 3 years male was admitted to the nose and throat service of Presbyterian Hospital July 29, 1937 with diagnosis of acute suppurative frontal sinusitis. He was semicomatose and irrational on admission. There was diffuse swelling of left frontal sinus area with marked edema of eyelids and in the region of the glabella. Blood culture July 3 revealed hemolytic *Staphylococcus aureus*. Bacteriophage was started on August 3 and he received 2 doses of total of 80 cubic centimeters. On August 3 the soft tissues over the frontal sinus were widely drained and an osteomyelitis of the bony vault of the sinus as demonstrated. Blood culture on August 3, 1937 as taken just before the second dose of phage and was negative. Following the first dose of phage the temperature dropped and the patient began to grow rational. He went on to an uneventful recovery, throat developing demonstrable abscesses.

This was a case of septicemia with the principal focus of distribution in the dangerous area of the left frontal sinus. The blood culture in this case became negative after the first dose of phage. As near as can be accurately determined the total duration of the sepsis in this case was about 4 days.

CASE 6 M.P. aged 4 years, male, admitted to the medical service of Presbyterian Hospital April 6, 1938 with diagnosis of fever of unknown etiology. Three days prior to admission he had had shaking chills lasting 5 minutes. During the next 3 days he ran spiking fever ranging between 2 and 3 degrees. On admission he was semicomatose and irrational. The only positive physical finding

was pain on motion of right hip. There was slight swelling and tenderness over the great trochanter and neck of the femur but no redness. The first diagnosis as rheumatic fever. A blood culture on April 3 revealed hemolytic *Staphylococcus aureus*. During the next 7 days he was given sulfanilamide 3.6 gram daily. During this time the blood culture remained positive and his clinical picture became progressively worse without evidence of any distributing focus other than pain in the right hip. X-ray films showed no evidence of an arthritis or osteomyelitis. On April 9, 1938, he was started on intravenous bacteriophage. A week after the first positive blood culture. He was rapidly worked up to 100 cubic centimeters per day and over a period of 3 days received 900 cubic centimeters of phage. Four days after starting bacteriophage the blood culture was negative and the patient began to improve clinically with return of mental faculties and drop in his temperature to normal. He then made an uneventful recovery.

This case illustrated 2 interesting features. First that sulfanilamide failed to control or stop the septicemia, second, that this is the only case in the series in which a distributing focus was not found with certainty. Follow-up examinations on this patient have given entirely normal results.

SUMMARY AND CONCLUSION

1. Thirty-six consecutive unselected cases of *Staphylococcus aureus* septicemia treated with bacteriophage have been presented.

2. An additional 54 unselected cases have been taken from the records of the Presbyterian Hospital as a control group.

3. In presenting the 36 cases in this series we have divided them into 2 groups: those treated prior to October 1936 and those treated subsequently. In 1936 the potency of our phage was markedly improved and the amount given was considerably increased.

4. A new method for determining the potency of phage has been briefly discussed. The phages used during the last 2 years were not only able to clear the culture of the organism in liquid medium but to prevent subsequent growth on a blood agar plate. To this phage we have given the name double potency phage.

5. The method of administering the bacteriophage has been outlined.

6. The frequency of metastatic lesions has been disclosed.

7. The mortality in this series was (a) early group, 15 cases or 73.5 per cent, (b) late group, 21 cases or 28.5 per cent, (c) entire group, 36 cases or 47.2 per cent, (d) control group, 54 cases or 81.4 per cent (untreated).

8. The cases of patients treated by others, using bacteriophage prepared in other laboratories, show mortality rates varying from 14.2 per cent in a series of 7 cases to 75 per cent in a series of 100.

9. A review of the literature shows the mortality of this disease in cases which did not receive bacteriophage to be about 80 per cent.

10. The possible causes for failure in the 6 fatal cases in the late group have been discussed.

11. The unusual features of 6 successful cases have been presented.

The results obtained in this series of cases, especially those in the last 2 years, make us feel certain that bacteriophage offers a favorable prognosis to patients ill with this disease if the phage is of a high potency, if it is given

in large doses and sufficiently early in the course of the disease.

We wish to express our gratitude and appreciation to the physicians and surgeon, who so kindly referred these cases to us and who have given us permission to publish these reports. Also we desire to express our appreciation for the aid of Anne Gunther Cooper and June O'Carroll Straus in the preparation of the bacteriophage.

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THE SURGICAL AND ANATOMICAL ASPECTS OF A CASE OF DOUBLE LOWER LIP

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CONGENITAL labial lip pits were described by Padgett in 1938 as one of the rarest anomalies of the human body. This abnormality is also known as "congenital fistula," "paramedian sinus," and by various other names. They are deforming malformations which are directly hereditary, predominant among females and rarer in the upper than in the lower lip.

Commonly included in the category of pit are those recesses which assume the form of an elongated slit or "split" rather than that of a slight, cylindrical depression. To the former group belongs the case of the present writers, since the malformation consisted of coronally placed anli. These sulci were situated just within the vermilion border of the lower lip, interrupted at the midline by a mound of mucous membrane (Fig. 1). They lay near the line of junction of the smooth or glabrous, and the papillose or so called villous, zones of the lip extending downward into the substance of the lip, both pits narrowed as they approached the level of the labial musculature.

The close relation of the sulcate fissures to the line dividing the labial zones invites speculation as to the cause of this uncommon malformation. In the present article the authors therefore propose not only to present the surgical and anatomical features of an additional case but also those aspects which are primarily comparative embryological.

CASE HISTORY

The patient, J. L., was a well nourished male, 9 years of age, weighing 55 pounds. He had "congenital pits" on his lower lip, bilaterally placed but not quite symmetrical; these pits occasioned no

trouble at any time. The patient's father, paternal uncle, and two cousins have similar bilateral, congenital sulci all of which were symptomless.

The sulci were located externally on the lower lip, one on each side of the medial line but with slight asymmetry (Fig. 2). Their arrangement suggested a wedge of tissue set into the lower lip in a coronal plane separating the free border into anteroposterior halves. The walls of each sulcus fell away gradually imparting to the orifice the form of a funnel and these walls gradually tapered to the floor where the diameter was that of a large match. Both pockets contained mucus. Dimensions of the depressions taken *in situ*, were as follows: left, 7.5 centimeter long, 7 centimeter deep; right, centimeter long, 0.65 centimeter deep. The pocket of the left half of the lip was more saccular than that of the right. Rising from the floor of each pit was small papillary mass. The tissue immediately surrounding the pits, and that occupying the center of the lip, possessed a more reddened and granular appearance than did the normal mucous membrane covering the remainder of the labial surface.

Surgical procedure. The deforming effect of the true pits or the larger sulci is often considerable and produces a condition so objectionable as to warrant surgical intervention. Correction is customarily accomplished by completely removing the prolapsed area of mucous membrane and the submucosal glandular tissue associated with the fistulous tract. Incision is made into the mucosal layer to the outer side of the depressed portion of the lip; after removal, the edges of the wound are brought together with sutures.

The wedge-shaped piece containing pits, in the current case, was excised by means of incisions which followed the long axis of the lip (Fig. 3), passing in front of and behind the involuted areas. After removal it was possible to bring the mucous membrane of the posterior labial surface forward to the anterior edge of the incision, and thereby obtain clean linear suture. Closure was made with silk without the use of dressing. After repair the lip which had previously appeared protuberant and bulbous (Fig. 2) assumed normal thickness and

This labial malformation tends to run in families by direct heredity according to Ludy and Blumery (1934). We have reviewed the literature extensively, while occurring in both sexes, more predominate among females. The cases recently reported by Den (1931) were from family groups, in which the deformity occurred in 5 and 8 individuals respectively.

*Measured in 30 per cent alcohol (after fixation in Bouin's solution, the pocket of the left side was 7 centimeter long; that of the right, centimeter).

From the Department of Surgery and the Department of Anatomy, Northwestern University Medical School, contribution No. 170 from the latter.

Is presented as an interesting symmetry by Ludy and Blumery (1934) who likewise make available very serviceable bibliography.

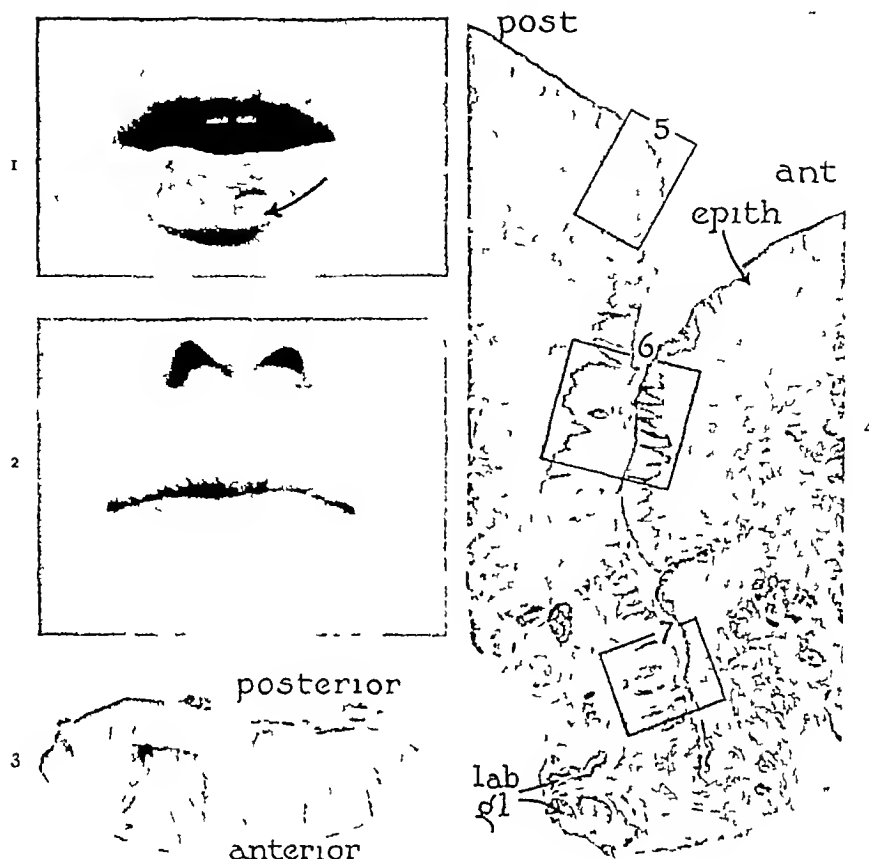


Fig 1 Lips of the patient prior to operation showing the normal upper and the sulcated, lower lip, the point of the arrow touches the line of junction of the glabrous and villous zones. Five sevenths natural size.

Fig 2 Lips 3 months after operation. Five sevenths natural size.

Fig 3 Excised piece, epithelial surface. $\times 17\frac{1}{2}$.

Fig 4 Sagittal section through the sulcus in the excised piece, center of the sulcated portion of the left side. The positions of the areas illustrated in Figures 5 to 7 are indicated by demarcated areas correspondingly numbered. $\times 11$.

contour (Fig 2). Recovery was uneventful and the patient was discharged in an improved condition.

ANATOMY

Excised piece (gross) Measured in alcohol the excised piece of labial tissue was 3.7 centimeters long, the maximum width of the right half was 1.1 centimeters, that of the left 1.4 centimeters, the maximum depth was 1.3 centimeters on the right side, and 1.0 centimeter on the left (Fig 3). The piece included the area between the sulci.

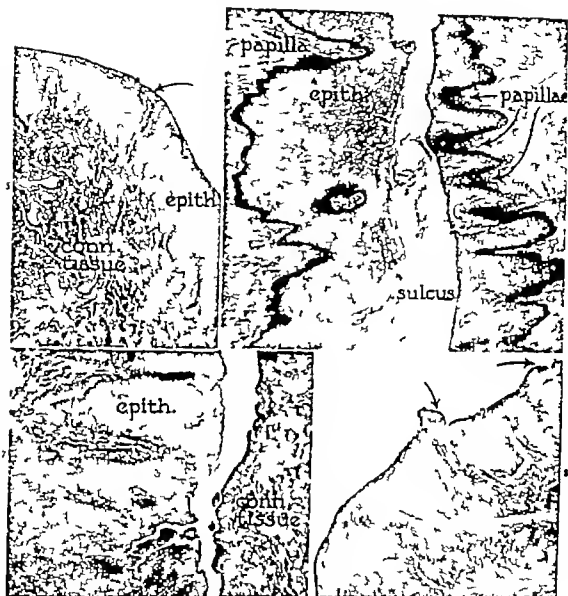
The surgical incision, anteriorly, passed just in front of the line of junction (Fig 1, arrow) of the two areas of the mucous mem-

brane, the forward area being the smooth zone, or pars glabra, the rear area the so called villous zone, or pars villosa, of the red portion of the lip.

SECTIONS (HISTOLOGY)¹

Tall dermal papillae from the subjacent connective tissue stroma project regularly into the basal aspect of the labial epithelium, this feature is very striking in the newborn infant (Fig 11), and progressively less so in the infant, child, and adult. The red color of

¹Serial sections passing through the piece in anteroposterior plane were prepared at a thickness of 10 or 15 microns. The tissue was fixed in Bouin's solution, embedded in nitrocellulose, the sections were stained with hematoxylin and eosin.



Figs. 5 to 8. Selected areas, at higher magnification (indicated area of the left half of the lip). Figures 5 to 7 represent portions of the section photomicrographed as Figure 4. $\times 52$.

Fig. 5. Tall dermal papilla (indicated by the arrow), near the mouth of the sulcus on the posterior wall of the latter.

Fig. 6. Tall papilla (right), thickened epithelium (left) in the middle third of the sulcus.

Fig. 7. Thickened epithelium (left), denuded connective tissue (right), in the lower third of the sulcus.

Fig. 8. Denuded dermal papilla, at the orifice of the sulcus, on the latter's anterior wall section near the one illustrated in Figures 4 & 7.

the lips is due to the presence of these tall papillae with associated vascular network, and to the occurrence of eleidin in the epithelial cells, rendering the latter translucent. In

the present specimen these papillae were abundant and of striking height (Figs. 4 to 8) they not only attained the surface (Fig. 5 arrow) but actually were present as papillose

projections (Fig 8, arrow) Glands of the branched tubular variety, regularly present in the oral mucous membrane, occurred here in the stroma, anterior and posterior to the sulcus (Fig 4), the ducts of these glands emptied most commonly into the lowermost part of the sulcus The mucous secretion produced by the glands was noted at physical examination Areas were present near the floor of the sulcus in which the epithelial layer was wanting, the connective tissue was left exposed (Fig 7)

The villous zone in the lip of the newborn infant is markedly thicker than the glabrous area (Figs 9 and 10), in the adult the difference is usually not striking, since the *pars villosa* is no longer an area of excessive epithelial hypertrophy However, in the present case this feature of thickening obtained to a degree within that part of the *villosa* which was carried downward into the sulcus (Figs 6 and 7), as if a primitive character were retained along an anomalous strip of tissue In the present case the sulcus is within villous territory, although the declivity begins near the junction of the glabrous and villous zones (Fig 1, arrow, Fig 11)

EMBRYOLOGY

Since the common form of double lip is a congenital anomaly, a brief description of the development of the normal lip may be of service in an attempt to understand the aberrant labial structure

In the lips of the human embryo of 70 millimeters length (CR),¹ the epithelium internal to the cutaneous area is noticeably thickened, (1, Fig 43), foreshadowing the formation of a true zonal arrangement of the mucous membrane in the late fetus and the newborn infant (Fig 11) The zones become less pronounced during the first few weeks of post-natal life and are usually indistinct in the adult When denuded of epithelium, "long, soft, villous-like outgrowths" appear on the innermost zone, when so treated, they were figured as "papillae" by Ruysch in 1707 Luschka, in 1863, first described them with modern precision, and since then they have been the subject of important studies by

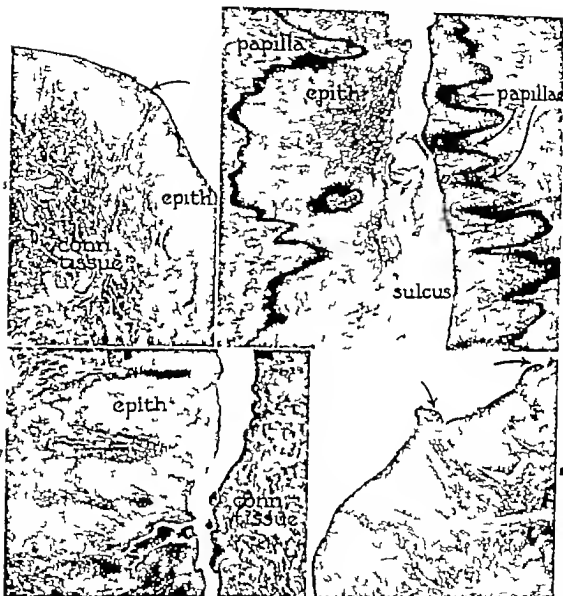
Neustaetter in 1895, Stieda in 1899, Ramm in 1905, and others The portion of the lip which bears these villi is clearly distinguishable to the naked eye, and the individual projections with their vascular cores may be seen on low magnification In 1895, Neustaetter stated that so far as his investigations showed, human lips alone are provided with these zones, the outer one of which is smooth, and the inner zone villous¹ ascribing the anatomical condition to the shortness of the nipples and flatness of the central area of the breasts in women, he is of the opinion that human infants require a special "Greifapparat" for an airtight contact²

But no such free villi occur in *pars villosa* of the lips of living infants, although suggested by Ramm in 1905 and once circulated widely in influential American textbooks The so-called villous zone bears no elevations prominent enough to be described as even nodular (1, 10) Yet this zone is clearly recognizable through its striate nature, an appearance produced by the presence of engorged capillaries within the underlying papillae While freshly excised, unfixed lips present the same conditions, in somewhat dried, excised lips, the "villous" zone is nodular, due to contraction of the epithelium over the tall papillae, and the latter is actually visible through the translucent investing epithelium When a fixing agent is applied to a fresh specimen, the epithelium shrinks and its surface becomes pebbly The hummocks thus produced lie over the dermal papillae and the depressed areas are situated between the papillae Only in specimens immersed for a considerable period in a macerating agent, either natural (amniotic fluid) or artificial (Ringer's solutions, etc), do free, tall, villi

¹The entrance to the mouth of vertebrates tends to be guarded by a pair of folds over which the skin makes a transition to the mucous membrane (1) This transition is effected typically through two zones The inner zone (*a pars villosa*) is regularly a region of very thick epithelium and of tall dermal papillae it is the seat of great proliferative activity leading to the production of various papillae and villi, both in the lower vertebrates and in mammals It may therefore be said that homologous lips are found at certain stages of development in some representatives of all classes of vertebrates The functions of the vertebrate lip are 3 sensory, prehensile and adhesive which are developed in varying degrees Those of the cod have the most conspicuous sense organs those of the tadpole with their epithelial teeth and of grazing animals through their intrinsic muscles are the most prehensile the lips of petromyzon and of the vampire provided with abundant villi are the most adhesive

²However among mammals nursing may be accomplished without this apparatus and even before lips have developed as in the opossum and rat

¹CR = Cephalon rump measurement



Figs. 5 to 8. Selected areas, at higher magnification (sulcated area of the left half of the lip). Figures 5 to 7 represent portions of the section photomicrographed as Figure 4. $\times 52$.

Fig. 5. Tall dermal papilla (indicated by the arrow) near the mouth of the sulcus on the posterior wall of the latter.

Fig. 6. Tall papilla (right); thickened epithelium (left), in the middle third of the sulcus.

Fig. 7. Thickened epithelium (left); denuded connective tissue (right) in the lower third of the sulcus.

Fig. 8. Denuded dermal papilla, at the orifice of the sulcus, on the latter's anterior wall; section near the one illustrated in Figures 4 to 7.

the lips is due to the presence of these tall papillae with associated vascular network, and to the occurrence of elastin in the epithelial cells rendering the layer translucent. In

the present specimen these papillae were abundant and of striking height (Figs. 4 to 8); they not only attained the surface (Fig. 5, arrow) but actually were present as papillose

herein the line of separation between the two zones (Fig 1, arrow) lay at the anterior edge of the sulcus, the latter, through the greater part of its depth was therefore bounded anteriorly and posteriorly by the thicker tissue of the pars villosa. As pointed out by Neustaetter, the furrow in congenital double lip constitutes a boundary line of exaggerated proportions between the regularly distinguishable zones of the lip. The effect is that which would be produced were the ordinary sulcus (Fig 11) deepened, and by some mechanism, the deepening made to involve the villous zone chiefly.

The present authors' view is, therefore, in essential agreement with that of Neustaetter and recognizes the obvious anatomical fact that the fetal lip is furrowed coronally (Figs 10 and 11). Other investigators have devised a number of explanations none of which is tenable.¹ Thus the pits have been regarded as sequelæ of the intra-uterine disease affecting the labial glands, but this explanation does not account for the fact that there are predilective sites of occurrence, nor for the length of the sulcate depressions in some cases. Similar objection could be lodged reasonably against the notion that the deformity is caused by amniotic adhesion. Other investi-

gators believe that during early stages of embryonic development the fistulous tract is formed through anchorage of the basal part of bilaterally placed, secondary notches, but the coronal plane assumed by the depressions could not be explained by such a theory.

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¹Discussed fully by Ludy and Shirazy (1938) and hence not requiring repetition here.



Fig. 9. Vertical section through the upper lip of a newborn infant, left half of the mouth near the angle. Macerated 24 hours in Ringer's solution, fixed in Zenker's fluid (Fig. 67). The names of the lip are shown, and the arrow is the point of junction of glabrous and villous zones. A thick sulcus sometimes occurs (Fig. 13). $\times 4$.

appear (Fig. 9). Although many villi appear as free projections, considerable of the investing layer remains. It seems safe to assume that occurrence of free villi (Figs. 5 and 8) and of bare fibrous stroma (Fig. 7) in the authors' specimen is due to similar macerating action of the salivary and mucoid secretion retained with the labial sulci.

In fixed preparations quite regularly and occasionally in lips of living subjects, the transition from the villous to the smooth zone is marked by an elongated depression. In some specimens of lip from newborn infants the sulcus which separates the glabrous from the villous zone is pronounced especially so following excision and fixation (Figs. 10 and 11).

In sections of the macerated lip the histological basis of these gross differences is demonstrated (Figs. 10 and 11). The smooth, thin, mucous membrane of the pars glabra becomes continuous with the thicker mucosa of the pars villosa on the floor of the sulcus, the glabrous membrane forming the anterior and the villous the posterior wall of the sulcus

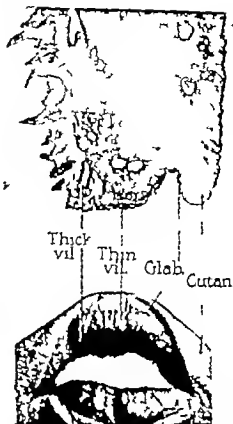


Fig. 10, top. Section through the right half of the upper lip photographed in Figure 6 (o, Figs. 5, 8, etc.) Showing the zones with the sulcus demarcating them (at arrow). Cutan, cutaneous zone; glab, glabrous zone; vil, villous zone. $\times 75$.

Fig. 10, bottom. Macerated specimen of excised lips of still-born fetus, natural maceration, i.e., intra-uterine, by aseptic field. Showing the pronounced areolar character of the lips, and the prominent sulcus (at arrow) separating glabrous and villous zones (Fig. 13 is section from this specimen).

itself the mucous membrane increases rapidly in thickness as it extends into the mouth, contains progressively taller dermal papillae which, invaded by the remnant of the epithelial stratum, stand higher as free projections (Fig. 10).

Although the pars villosa diminishes in thickness in the early postnatal month and the distinction between villosa and glabra becomes less distinct, the differences between the two are usually strong enough to render them distinguishable in naked-eye examination. In the authors' surgical case discussed

¹As correspondence Professor Frederick T. Lewis of Harvard has pointed out to us, the small divisions of the lamina propria have not yet been recognized as part of the mucous membrane. Professor Lewis points out, rightly, so the chance of error, that the villi are an epidermal outgrowth, and the lamina propria is a dermal outgrowth of its thick epidermis. It is true where papillae are especially tall and the epidermis considerably thick, they are papillae, laminae, or epidermis. The term pars villosa would not only indicate the thickness of the epidermis but would emphasize the fact that Ruych derived that name (epilabium) for the thick transverse layer covering these tall papillae or "villi."

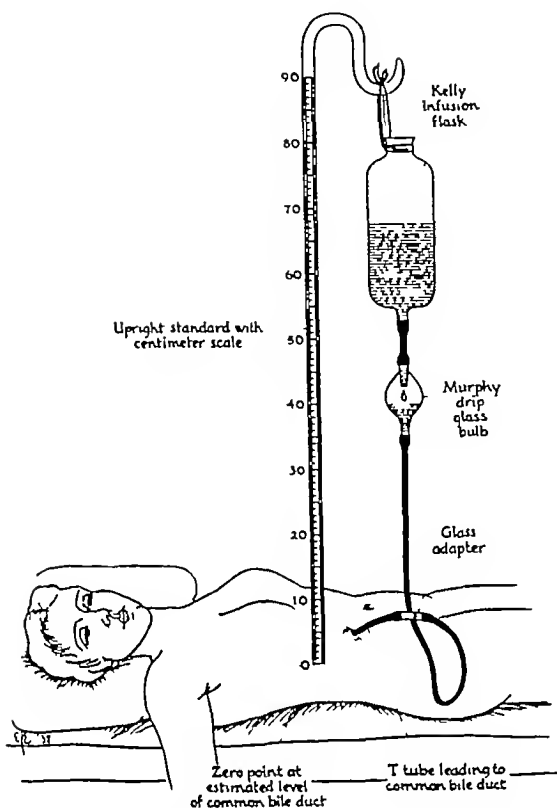


Fig 1 Method employed to produce pain by hydraulic distention of the biliary ducts

electrical drop-counter recorded the flow of fluid

OBSERVATIONS

Sudden distention of the common bile duct with normal salt solution under pressures varying from 50 to 100 centimeters of solution induced deep epigastric or right upper quadrant pain in all but 1 of the 30 patients. Gradual distention, on the other hand, failed to induce pain. In 18 of the 29 patients experiencing pain the sensation remained localized, while in the 11 remaining it also radiated to the interscapular or right subscapular region. The deep epigastric or right upper quadrant pain preceded the development of the pain in the back. The interval was usually about 30 seconds. In most cases the pain was intense, but occasionally it consisted of only a relatively mild discomfort. In one case there was complete absence of pain.

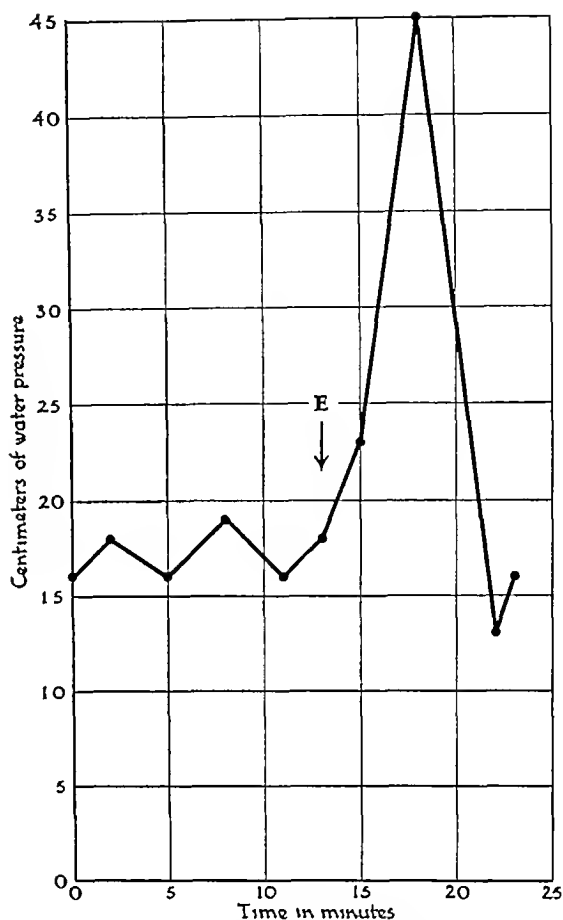


Fig 2 Chart illustrating increased resistance to flow of fluid from the bile duct into the intestine, resulting from the production of spasm at the sphincter of Oddi. Six preliminary measurements of the sphincter resistance (method of Elman and McMaster) varied from 16 to 19 centimeters of water. At point E the infusion flask (Fig 1) was momentarily raised to a level 50 centimeters above the zero point. Following this, sphincter resistance measurements were again made, and 4 minutes after the sudden distention of the bile ducts a pressure of 45 centimeters of water was required to force fluid into the intestine. This indicated that the momentary distention of the bile duct produced an obstruction to the flow, and other evidence (Fig 4) demonstrates that this obstruction is due to a contraction of the sphincter of Oddi. The sphincter spasm had relaxed after 8 minutes.

The pain subsided within a minute after removing the increased pressure unless spasm persisted at the sphincter, in which case the pain persisted until the spasm subsided. The pain induced by spasm disappeared within 5 or 10 seconds after relaxation. The presence of spasm was established by measuring the

AN EXPERIMENTAL STUDY OF PAIN IN THE HUMAN BILIARY TRACT INDUCED BY SPASM OF THE SPHINCTER OF ODDI

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THE most striking and characteristic symptom commonly experienced by patients suffering from disease of the extrahepatic biliary tract is the colicky pain that occurs in the epigastrium or right hypochondrium and that radiates, frequently to the subscapular or interscapular region. Yet, notwithstanding the recognition long accorded to this clinical observation, the neurological mechanism has never been fully revealed. Recently we have had an opportunity to conduct studies of biliary tract pain upon unanesthetized human subjects, and it is with the hope that these experiments may contribute to the solution of this problem that the following observations are reported.

METHOD OF EXPERIMENTATION

Thirty patients who had previously undergone choledochotomy and intubation of the common bile duct voluntarily submitted themselves as subjects for these studies. Of these 8 were men and 22 were women, and their ages ranged from 25 to 70 years.

Distention was accomplished by the injection of fluid under pressure. The apparatus (Fig. 1) consisted of an infusion flask connected by a rubber tube to the choledochotomy tube. A Murphy drip bulb was included in the system so that observations of flow could be made. This made it possible to measure the resistance offered by the sphincter at the choledochoduodenal junction by a method similar to that of Elman and McMaster. The fluid injected was sterile, physiological salt solution. After measuring the sphincter resistance by observing the level at which fluid was admitted into the intestine as revealed by the dropping of fluid through the glass bulb pain

was induced by suddenly raising the flask and thereby distending the ducts with the sterile solution under pressures varying from 50 to 100 centimeters of water. The added pressure was sustained for periods of 30 to 300 seconds. In some instances spasm developed, presumably at the sphincter choledochus.¹ Occasionally this spasm was sufficiently intense to stop the flow of fluid even when pressures as high as 50 or 60 centimeters of water were being used. The patients were closely observed to determine the effects of the procedure. Although they were interrogated concerning their sensations during the period of the experiments, leading questions were carefully avoided. Much of the information was volunteered by the subjects without the necessity for questioning.

In several cases kymographic records were made to demonstrate the production of an increased resistance to the flow of fluid into the intestine as a result of sudden distention of the bile ducts. The hydrostatic pressure within the system, the intraduodenal pressure and the number of drops flowing through the glass bulb were recorded simultaneously. The pressure within the system was recorded by connecting a mercury manometer to the system of tubes leading to the bile duct. The intraduodenal pressure was measured by connecting a tambour to a duodenal tube attached to a balloon placed in the duodenum. The position of the balloon was determined by roentgenoscopic examination. A simple

¹This is the term used by Schlegel and Boyden in their detailed study of the development of the human sphincter of Oddi, to designate that narrow sheath of circular muscle that immediately surrounds the terminal intraluminal portion of the common bile duct. As pointed out by these authors, represents only portion, but perhaps the most significant part of that complicated musculature which Oddi originally designated as the Sphincter du choledochus. Apparently varies greatly in different species but is especially well developed in man (Boyden, J.).

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²This series includes 5 cases already reported (1).

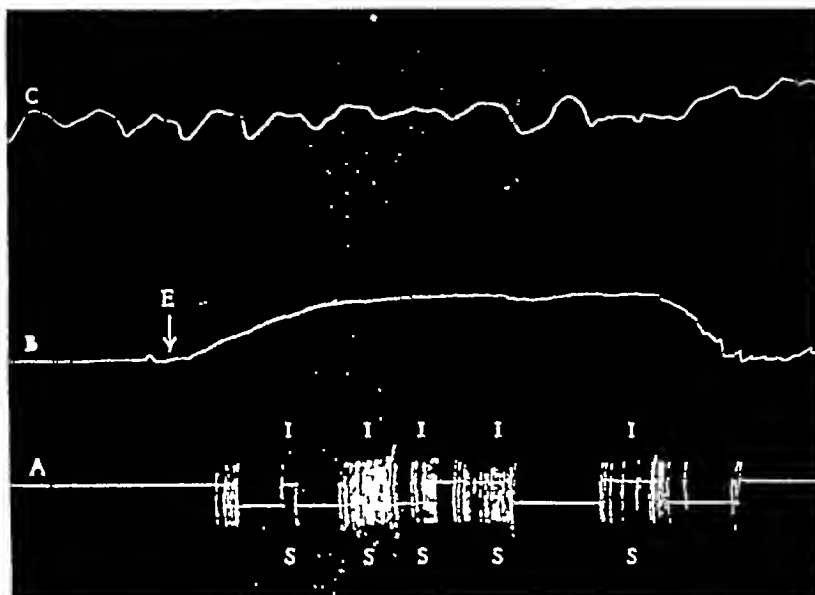


Fig. 4. Kymographic record of the flow of fluid through the bile duct into the intestine as recorded by a drop-counter, *I*, the pressure within the system used to distend the bile ducts, *B*, and the intraduodenal pressure, *C*. At point *E* the pressure within the distending system was raised from 18 to 50 centimeters of water, where it was maintained for 40 seconds. The method of estimating the rate of flow is the same as that used in Figure 3. In this case also, the subject experienced pain throughout the period of distention, but again the pain was more intense (indicated by points, *I*) when there was an increased resistance to flow as revealed by a slowing of the stream to a point where individual drops could be recorded, or even to a temporary complete cessation of flow (indicated by points, *S*). There was no relationship between the intraduodenal pressure and the development of the pain. It seems apparent, therefore, that the increased resistance to flow is not due to a contraction of the duodenal musculature but rather to an independent action of the sphincter of Oddi.

time of the roentgenoscopic examination the patients were in the erect position, whereas our other observations were made with the patients supine. Whether or not this difference in position could account for the difference in results can not be stated.

VISCERAL PAIN, ORIGIN AND CAUSE

While a few investigators still deny the existence of true visceral pain, numerous recent experimental contributions have indicated fairly conclusively that visceral pain actually does exist. It is well known, however, that endings of the afferent fibers in the viscera are insensitive to many types of stimulation which initiate impulses in somatic fibers. Adequate stimuli for elicitation of visceral pain depend upon pressure on nerve endings in the end organ, such as is produced

by spasm (Ryle) or distention (Hurst, 9). Other types of stimulation are much less effective. The impulses initiated by spasm and by distention are probably identical. In our experiments similar reactions followed each of these two types of stimulation. This being true, one might assume that the same type of receptor acts in both instances. It is a fact, however, that the pain resulting from spasm was much more intense than the pain associated with simple distention.

Once initiated, impulses from the region of the biliary tract travel to the central nervous system by way of the major splanchnic nerves (Fig. 5). The first neurone of this system has its cell body in the spinal ganglion. The central fibers of this neurone enter the spinal cord through the dorsal root. The observations of Davis (4, 5) indicate that, within the spinal



Fig. 3. Kymographic record of the pressure within the system used to distend the bile ducts, *P*, and the flow of fluid through the bile duct into the intestine as recorded by drop-counter *A*. At point *E* the pressure within the distending system was raised from 24 to 65 centimeters of water at which level it was maintained for 30 seconds. When no fluid was passing through the drop-counter the recording level was at the upper level on the graph. When individual drops flowed, separate excursions of the lever occurred. When there was constant stream, the lever was held at the lower level. The subject experienced pain throughout the period of distention, but during the periods when there was increased resistance to flow as revealed by slowing of the stream to a point where individual drops could be recorded or even to temporary complete cessation of flow (indicated by points, *S*) the pain was much more intense (indicated by points, *P*).

resistance to the flow of fluid through the glass bulb (Fig. 1). Spastic contraction of the sphincter increased the resistance to flow of the fluid so that pressures of 50 or 60 centimeters of water were required to force fluid into the intestine, whereas normally the sphincter resistance varies from 9 to 23 centimeters of water and is usually around 15 centimeters. The occurrence of spasm following a momentary increase in pressure is illustrated in Figure 2. Such spasm produced pain which is similar to but much more intense than, the pain produced by simple distention.

Figure 3 illustrates graphically the fact that pain was more intense during the periods of increased resistance to flow than during periods of simple distention. That the increased resistance to flow was due to a spasm, presumably at the sphincter of Oddi, rather than to a contraction of the duodenal musculature is demonstrated by the kymographic record reproduced in Figure 4.

One might expect that the 25 patients who experienced reference of pain to the back prior to operation would suffer a similar subscapular or interscapular pain when the ducts were distended. Only 11 of these however experienced such radiation, while in 18 the sensation remained localized in the epigastrium or right hypochondrium. Further

more there was radiation of pain to the back in one of the subjects who had had no such radiation before operation. The patients stated that the pain in the epigastrium or right upper quadrant was practically identical with the pain previously experienced during periods of biliary tract disease.

Associated with the pain there was a marked rigidity of the muscles of the abdominal wall, greatest in the right upper quadrant. This rigidity disappeared as soon as the pain was relieved. Inspiratory distress was a frequent accompaniment. It was impossible to examine for localized tenderness because of the intensity of the pain already present.

There was vomiting in 2 cases, and 1 other patient vomited a short time after the completion of the experiment. A feeling of fullness in the epigastrium was frequently described and 5 patients complained of nausea. One patient fainted, presumably as a result of the severity of the pain.

Six patients belched when the ducts were distended. Attempts were made to study the mechanics of the eructation in 2 patients by roentgenoscopic examination after the administration of a small barium meal. In both instances it was impossible to produce belching during the period of this examination. At the

were allowed to recover from general anesthesia sufficiently to answer questions intelligently. He found that distention of the gall bladder was followed by deep epigastric discomfort which was neither referred to the gall-bladder region nor to the back. Two of his patients experienced no discomfort regardless of the amount of distention. Distention of the gall bladder producing contact with the parietal peritoneum gave localized pain which could be markedly relieved by infiltration of the overlying abdominal wall by procaine hydrochloride. Inspiratory distress also followed distention of the gall bladder.

Similar, but more pronounced findings were reported by Zollinger following distention of the common bile duct in three human subjects, and in these patients likewise, there was no reference of the pain to the gall-bladder region or the back. Vomiting occurred in 2 of his 3 cases.

Zollinger and Walter (19), employing the direct method of stimulating the gastrointestinal tract which was introduced by Boyden and Rigler (3), studied the effects of faradic stimulation of the common bile duct in 8 patients in whom an electrode had been incorporated in the common duct catheter at the time of choledochostomy. They found that the pain resulting from faradic stimulation was referred to the back in 4 of the 8 patients. They stated that the pain was referred to the back in those patients who described such radiation before operation, and expressed the belief that reference of pain to the back could be produced by faradic stimulation but not by distention. Opposed to this theory, however, are the observations of Boyden and Rigler (3) who were unable to produce pain in the back by faradic stimulation of the stomach, notwithstanding the occurrence of such pain in some cases of gastric ulcer.

It has been demonstrated by Schrager and Ivy that distention of the biliary passages in dogs is followed by evidences of pain, inhibition of respiration, and salivation. The salivation was interpreted by the investigators as indicative of nausea. Vomiting was sometimes produced.

Ogilvie, studying the effects of distention

of the gall bladder in patients who had undergone cholecystostomy, found that distention of the gall bladder produced a sensation varying from extreme discomfort to actual pain. The pain was vaguely localized to the region of the gall bladder in 4 of 6 cases, once to the xiphoid process of the sternum and once to the left hypochondrium. Reference to the back occurred in only 1 case, and in this patient it spread from the left hypochondrium around the costal margin to the left scapular region. Nausea was present in 4 of the 6 cases, but vomiting did not occur.

In conclusion, it is difficult to explain the significant fact that reference of pain to the back, which can not be related in any simple way to the intensity of the stimulus, occurs in some patients and not in others. Our only contributions to this problem are that anterior pain is primary, and that a latent period of approximately 30 seconds always intervenes between the appearance of sensations in the regions of the distributions of the anterior and posterior divisions of the thoracic nerves. This suggests that reference of pain to the back is the result of a spreading of impulses in the central nervous system. The absence of such a spreading in more than half of the 30 cases submitted to comparable stimuli, may be due either to differences in physiological thresholds or, as Boyden and Rigler (3) have suggested, to a variability in juxtaposition of the nerve endings from the anterior and posterior divisions of the thoracic nerves within the central nervous system.

SUMMARY

1 Studies of visceral pain resulting from distention of the common bile duct were made in 30 unanesthetized human subjects who had previously undergone cholecystectomy and choledochostomy.

2 Twenty-nine patients experienced deep epigastric or right upper quadrant pain following sudden distention of the common bile duct, and in 11 patients there was radiation of the pain to the right subscapular or interscapular area.

3 In some cases spasm of the sphincter of Oddi could be produced by sudden distention of the bile ducts. Such spasm produced pain

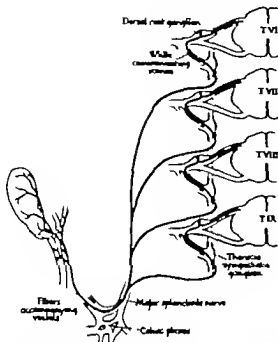


Fig 5 The pathway for the transmission from the biliary tract to the central nervous system of impulses leading to pain sensations.

cord, the visceral afferent impulses ascend in relays of short neurones, with synapses in the gray matter of the cord. It is not known whether the visceral pain impulses pass directly to the cerebrum by way of a visceral thalamic-cerebral radiation or whether a transfer occurs in the thalamus so that impulses are conducted thence to the cerebrum by way of tertiary somatic sensory neurones.

The pain which the patients experienced was not localized to a small region but was always rather diffuse in the epigastrium or right hypochondrium. This is in agreement with the findings of Head, Livingston, Ivy, Davis, Pollock, and Stone (6) and others. Ivy has shown that localization of visceral pain to a specific organ (stomach, duodenum, and jejunum) can be accomplished by a trained individual. Davis, Pollock, and Stone (6) have shown experimentally that distention of the gall bladder in cats results in evidence of pain even after all thoracic nerves have been divided.

In certain individuals in the presence of adequate stimulation a referred pain to the back also results. This consists of an "erroneous reference" of the pain to a somatic part innervated by nerves originating in the segments of the spinal cord receiving visceral afferent fibers from the stimulated viscera. In the case of the biliary tract the primary receptive centers are located at the sixth to ninth thoracic levels, and if as rarely the phrenic terminals become involved they are at the level of the fourth cervical segment. The somatic regions to which pain resulting from biliary irritation is referred are the right subscapular or interscapular regions, and occasionally the right shoulder-cap area.

In one of our patients pain failed to develop in spite of sudden distention under a pressure of 100 centimeters of water. It is well known that there are marked individual differences in pain thresholds and in cerebral receptive ability. Apparently such differences account for the absence of pain in this case. Ivy has pointed out the clinical significance of this individual variation in relation to the so called "silent" cases of cholecystitis and cholelithiasis.

Our results differ from those of other investigators, whose observations are considered in the following paragraphs, in several respects. First reference of the pain to the back occurred in 11 of our 30 patients subjected to distention of the common bile duct. Second, a time relationship between the development of the pain in the epigastrium and right hypochondrium, and the pain in the interscapular or right subscapular region, has been established. The pain in the back developed later than the pain in the epigastrium and right hypochondrium by an interval of about 30 seconds. Furthermore the pain in the back never occurred in the absence of pain in the epigastrium or right hypochondrium. Third, the pain in the back occurred in one patient who had not experienced it in connection with his biliary tract disease.

Zollinger (17-18) studied the effects of distention of the gall bladder in 9 human subjects at the time of operation. A few of his studies were made using patients operated upon under local anesthesia. The remainder

A SECRETORY DEPRESSANT IN THE ACHILORHYDRIC GASTRIC JUICE OF PATIENTS WITH CARCINOMA OF THE STOMACH

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IN a previous communication (2) it was reported that when 16 of 18 different samples of achlorhydric gastric juice from patients with pernicious anemia were injected intravenously into dogs with gastric pouches that had been stimulated by feeding the animals, a transitory depression of pouch secretion and achlorhydria occurred. In a series of controls (34 samples), consisting of gastric juices from patients not suffering from pernicious anemia or malignant neoplasms, approximately 18 per cent of the samples produced a similar result. The difference between the 2 groups was considered great enough to suggest that in pernicious anemia there may be an excess of a gastric secretory depressant in the stomach.

Certain other diseases are reported to be characterized by an abnormally high incidence of gastric hyposecretion and achlorhydria, these include cholecystitis, carcinoma of the pancreas, diabetes mellitus, leucemia, and carcinoma of the stomach. The question of a relationship between the gastritis of pernicious anemia and the gastritis which is now frequently conceded to accompany and even precede the development of gastric carcinoma has been discussed in the literature for many years. Thus, in view of the mentioned experiments with pernicious anemia gastric juice, similar experiments were conducted using gastric juice from patients with carcinoma of the stomach.

In male and female dogs weighing 5 to 15 kilograms, subtotal gastric pouches and "wedge" pouches (Fig 1) were made and in some in-

stances Heidenhain pouches. Because of the wide variation in secretion from the latter, no dog with this type of pouch was employed in which adequate control observations did not demonstrate the reliability of continued secretion of highly acid juice under the stimulation of cooked meat at intervals over periods of several hours.

A typical experiment consisted of placing the dogs on a table where a limited amount of movement was possible, free access to water was afforded and pieces of cooked lean meat, approximately the size of a human digit, given at intervals of 10 to 40 minutes. A glass Soxhlet flask was suspended beneath the cannulae. The pouch secretion was collected at 10 minute intervals and titrated for free and com-

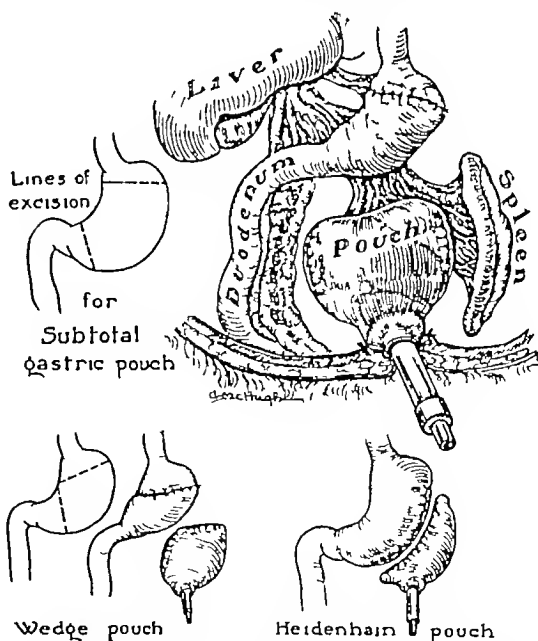


Fig 1 Schematic illustrations showing types of gastric pouches used in dogs

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Paper read before the Chicago Surgical Society May 5 1939

which was similar to but more intense than the pain produced by simple distention. Contraction of the duodenal musculature apparently did not play a significant rôle in the production of this pain.

4. The pain in the back developed later than the pain in the epigastrium or right hypochondrium by an interval of about 30 seconds.

5. Nausea occurred in 5 patients, 3 of whom vomited and 6 patients belched when the bile ducts were distended.

We are indebted to Dr. E. A. Boyden of the Department of Anatomy for suggestions and criticisms, and to Dr. I. Vigness, Department of Biophysics for technical assistance in the preparation of the drop-counter.

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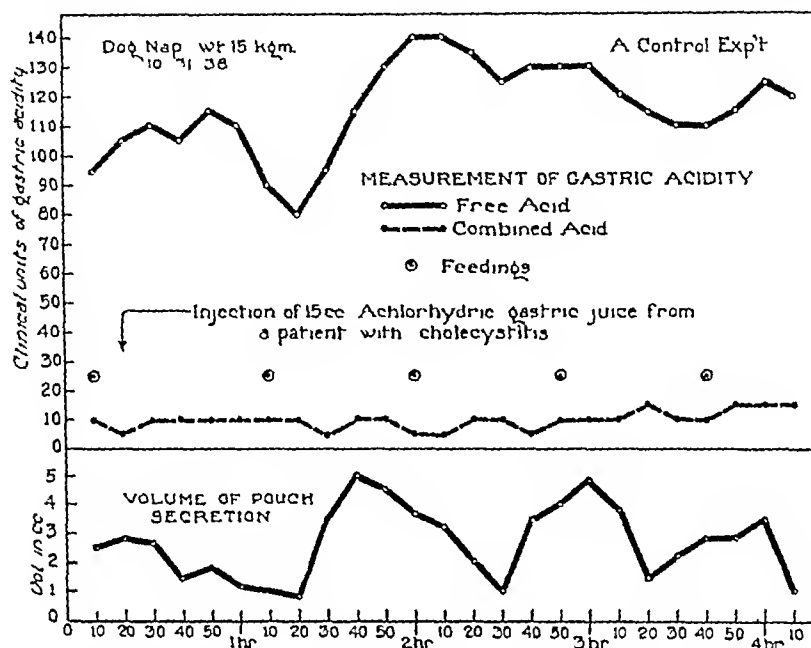


Fig 2 Graph of control experiment in which achlorhydric gastric juice from a patient with cholecystitis was injected into a pouched dog in which secretion was stimulated by repeated meat feedings. The injection was not followed by a significant alteration in the pouch secretion.

Experiment A Thirty samples of achlorhydric gastric juice from as many patients with carcinoma of the stomach were tested. The results were summarized in Table I. In some instances the quantities of juice recovered from the patient were so small that only one satisfactory experiment was obtained. However, such samples are not considered in

TABLE II—SUMMARY OF RESULTS WITH SAMPLES OF GASTRIC JUICES USED AS CONTROLS

	Number of samples	Results of experiments		Per cent positive
		Negative	Positive	
Human gastric juice, average or high acid from patients not presenting pernicious anemia or gastric carcinoma	80	64	16	20
Acid gastric juices from carcinomatous stomachs	12	10	2	17
Achlorhydric juices from cases other than pernicious anemia or malignant neoplasm anywhere in the body	25	18	7	28
Totals	117	92	25	21
Achlorhydric juices from patients with carcinoma of the stomach (from Table I)	27	6	21	78

the estimation of results (Cases 1, 12, and 17). Where at least 3 experiments were possible, 2 positive results were considered necessary for the sample to be regarded as a positive sample. In Case 4 the 1 positive experiment out of 3 was deemed insufficient to warrant the sample being considered as containing the secretory depressant. If this were a control sample, however, it would be considered as positive. As is to be expected in biological experiments with crude substances, uniform results are not always obtained, thus with some of the positive samples negative experiments were not infrequently obtained even in the dogs which yielded positive results on other occasions.

Of 27 samples, 21 were considered to contain a gastric secretory depressant, that is 78 per cent of the series. In 5 instances the positive juices were boiled for 10 minutes and water then added to make up the original volume. Injection of such boiled juices into the same dogs which gave positive results with the unboiled portions did not result in a depression of the pouch secretions. The latent period

TABLE I.—ACIDORHYDRIC JUICES FROM PATIENTS WITH CARCENOMA OF THE STOMACH

Cases No.	Dog	Result	Result with heated juice
	Mank	+	
	Tru Mank	++++	Tru
	Kg Nap	++++	Kg
	May Kg Nap	+	
		-	
1	Kg Nap Nap	+	Kg
		+	Kap
2	Kg Nap	++++	
	Scm Scm	-	
3	Scm Nap Nap	++	
	Eva Eva	++	Eva
		++++	
10	Eva	++++	
	K Charl	+	
		-	
	Eva	+	Eva
	Eva	+	
		+++	
11	Le	++++	
12	Le	++	
		+++	
13	Le	-	
		-	
	Kg	-	
14	Scm	+++	
15	Scm	++++	
16	Le	++	
		-	
	Le	+++	
		+++	
17	Le	+	
		++	
18	Le	+++	
		+++	
19	Le	-	
		-	
20	Le	+++	
		+	
21	Le	+++	
		+	
22	Le	+	
		+	
23	Le	+++	
		+	

TABLE I.—CONTINUED

Cases No.	Dog	Result	Result with heated juice
24	Le	+++	
	Le	+++	
25	Rad Kap	+++	
26	Le	-	
	Rad	-	
27	Le	-	
	Ames	-	
	Rad	-	
28	Le	+++	
	Ames	-	
	Rad	+++	

Since secretory depressant effects were sought, the arbitrary system of expressing the results of such operations upon the pouch secretion was as follows: — No depressant effect on pouch secretion (Fig. 1); + reduction of volume of secretion to approximately 5 drops or less per 24 hours period for at least two such periods, or reduction of free acid to 50 clinical units or less when the color of the juice was at least 50 to 60 clinical units or higher during control observations; ++ achylodynia for 20 to 30 minutes; +++ achylodynia for 30 to 60 minutes; ++++ achylodynia for 60 minutes or longer (Fig. 2).

combined acid by means of tenth normal sodium hydroxide using Toepfer's reagent and phenolphthalein as indicators, respectively. The results are expressed in "clinical units." When vigorous secretion was established the human gastric juice to be tested, neutralized to litmus if it was acid was injected intravenously in an extremity vein in an arbitrary dose of 2 cubic centimeter of the juice per kilogram weight of the dog. If depressant effects were noted the experiment was always continued until the pouch secretion returned spontaneously to pre-injection levels of volume and acidity. For reasons stated below rectal temperatures were taken in all dogs at 10 to 30 minute intervals during each experiment.

All samples of human gastric juice were obtained according to the usual technique for histamine test of gastric secretion performed in the morning after a night's starvation. Before injection the samples were centrifuged to remove gross particles. If very mucoid water was added to reduce the viscosity the added volume being taken into account when the injections into the dogs were made.

Preliminary control observations showed that in 12 experiments intravenous injection of neutralized dog's pouch juice into the dog from which it was obtained or into another dog did not result in a depression of pouch secretion.

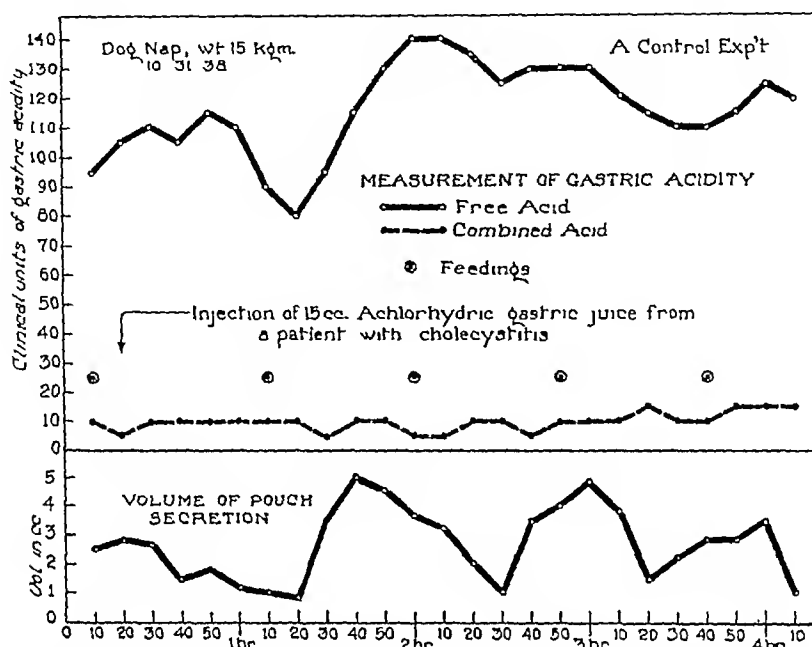


Fig 2 Graph of control experiment in which achlorhydric gastric juice from a patient with cholecystitis was injected into a pouched dog in which secretion was stimulated by repeated meat feedings. The injection was not followed by a significant alteration in the pouch secretion

Experiment A Thirty samples of achlorhydric gastric juice from as many patients with carcinoma of the stomach were tested. The results were summarized in Table I. In some instances the quantities of juice recovered from the patient were so small that only one satisfactory experiment was obtained. However, such samples are not considered in

TABLE II — SUMMARY OF RESULTS WITH SAMPLES OF GASTRIC JUICES USED AS CONTROLS

	Number of samples	Results of experiments		Per cent positive
		Negative	Positive	
Human gastric juice, average or high acid from patients not presenting pernicious anemia or gastric carcinoma	80	64	16	20
Acid gastric juices from carcinoma stomachs	12	10	2	17
Achlorhydric juices from cases other than pernicious anemia or malignant neoplasm anywhere in the body	25	18	7	28
Totals	117	92	25	21
Achlorhydric juices from patients with carcinoma of the stomach (from Table I)	27	6	21	78

the estimation of results (Cases 1, 12, and 17). Where at least 3 experiments were possible, 2 positive results were considered necessary for the sample to be regarded as a positive sample. In Case 4 the 1 positive experiment out of 3 was deemed insufficient to warrant the sample being considered as containing the secretory depressant. If this were a control sample, however, it would be considered as positive. As is to be expected in biological experiments with crude substances, uniform results are not always obtained, thus with some of the positive samples negative experiments were not infrequently obtained even in the dogs which yielded positive results on other occasions.

Of 27 samples, 21 were considered to contain a gastric secretory depressant, that is 78 per cent of the series. In 5 instances the positive juices were boiled for 10 minutes and water then added to make up the original volume. Injection of such boiled juices into the same dogs which gave positive results with the unboiled portions did not result in a depression of the pouch secretions. The latent period

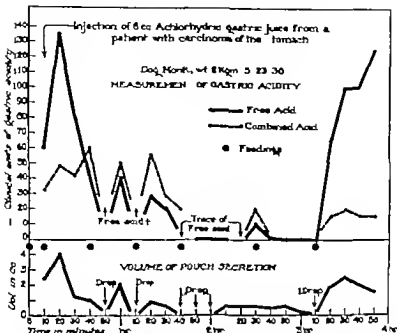


Fig. 3. Graph of experiment showing depression of pouch secretion following injection of achlorhydric gastric juice from patient with carcinoma of the stomach. Note eventual return of secretion and free acid after effects of the injection have worn off.

between injection and depression of pouch secretion was usually 20 to 60 minutes, although in some instances it was as long as 2 hours.

Experiment B Control experiments were conducted using (1) juices of normal or high acidity from patients without malignant tumors or pernicious anemia, (2) juices of patients with carcinoma of the stomach but normal or high acidity in the juice, and (3) with achlorhydric juices from patients not presenting malignant neoplasms or pernicious anemia. The results were tabulated according to the same criteria as employed for the experiments with achlorhydric juice from patients with carcinoma of the stomach. They are summarized in Table II. In most instances 2 to 4 experiments were performed with each sample.

In these control experiments a single positive experiment with a given sample was sufficient for that sample to be regarded as positive even though all other experiments with it were negative. Thus the criterion for tabulation of a sample as positive was less rigid than in group A. Of this control group, comprising juices from 80 patients, 30 per cent were positive.

All experiments could not be performed in all the dogs, but each dog in which positive results had been observed was also employed in many control experiments which for the most part yielded negative results.

EVALUATION OF RESULTS

Several factors must be taken into consideration in the evaluation of the results recorded above before assumption that the gastric secretory depression was due to a factor in the juice. It is necessary first, to rule out temperature as a factor in the secretory depression because a sudden rise in temperature to 40.5 or 40.6 degrees C. or above in fresh animals produced by an intravenous injection will in itself cause marked inhibition of gastric secretion and achlorhydria (5). Thus prior to use the dogs were immunized against such febrile reactions by repeated daily intravenous injections of small quantities of the juices. In some cases immunization to fever producing substances did not develop since high temperatures continued to occur after each injection but the dogs themselves developed the facility

to continue gastric secretion at temperatures as high as 42 degrees C. Such "temperature resistant" animals could of course be employed.

No correlation was possible between the age of the patient and the presence or absence of the gastric secretory depressant in the juice.

The positive experiments could not be accounted for by vomiting although this sometimes occurred after injection of both achlorhydric juices from cancerous stomachs and in control experiments. Once a vigorous secretion is established as a result of feeding, emptying the stomach by vomiting does not result in sudden cessation of pouch secretion. The latter may continue for an hour or more. If animals did vomit they ate voluntarily again 10 to 15 minutes later or were force fed cooked meat.

According to Browne and Vineberg, depression of the carbon dioxide combining power of the blood results in inhibition of gastric secretion. Carbon dioxide combining powers of samples of blood taken in the above experiments during the induced achlorhydric periods did not differ from those taken prior to the injections.

That special bacterial flora in achlorhydric stomachs might elaborate toxins, which would suppress gastric secretion, is not a likely explanation for the positive results, in view of the observations obtained using a series of achlorhydric juices from patients not presenting gastric cancer or pernicious anemia (Table II).

It is conceivable that prolonged vasodilation might eventually result in depression of gastric secretion. Experiments on anesthetized dogs whose carotid arteries were cannulated to a manometer showed that the juices which produced positive results in the experiments quoted did not produce profound and prolonged vasodilation. An appreciable and sustained drop in blood pressure was sometimes observed following intravenous injection of such juices but similar or even more marked lowering of the blood pressure also occurred with samples of juices which did not affect the secretions of the stimulated gastric pouches.

Experiments were conducted in which saliva from patients with a variety of diseases,

including gastric cancer and pernicious anemia, was injected instead of gastric juice into the pouched dogs. Positive and negative results were obtained but it is felt that these results constitute a problem apart from, although possibly related to, that dealt with in this report. Suffice it to say that the results obtained with saliva did not closely parallel those obtained with gastric juice from the same patient. If saliva which cannot be entirely kept out of a sample of juice from a patient introduces an additional factor, such a factor is also present in the control experiments.

It would thus appear that the secretory depressions and achlorhydrias observed in the gastric pouches in experiments of groups A and B quoted, were not artifactual but due to some depressant in the human gastric juices.

Enterogastrone is a hormone, or chalone, described by Kosaka and Lim, and by Ivy, and is generated in the duodenal mucosa when this is in contact with fat. When absorbed or injected into the circulation it has been shown to cause inhibition of gastric secretion and free acid liberation. In all the patients herein studied, the gastric juice was collected in the morning after a night's starvation and thus fat was not present in the duodenum. Furthermore, 4 pouched dogs were fed a small piece of meat and this was followed by frequent feedings over a period of 2 hours of pure suet dipped in olive oil. One hour after the first feeding and for a period of 3 hours thereafter the juices, which for the most part contained free acid, were collected, pooled, stored on ice and the following day 1 cubic centimeter per kilogram of weight was injected into the same animals which, however, were now fed only lean meat. Of 10 experiments 8 were negative, one a one plus and one a two plus positive. Thus under optimum physiological conditions for its production enterogastrone does not appear readily and in high concentration in the gastric juice of dogs. Enterogastrone produced in the usual known manner could hardly be the explanation for the secretory depressant found in the human gastric juices employed in the experiments here mentioned.

From a review of the literature and in a series of experiments not reported here, it

would appear that inhibition of the volume of gastric secretion and free acid liberation might on occasion be observed in dogs as the result of intravenous injection of a wide variety of substances including drugs, such as atropine, watery extracts of various normal and pathological tissues, urine etc. Taken as a whole such reactions would seem non-specific and have little bearing on the question of gastric hyposecretion and achlorhydria in gastric cancer in man.

On the other hand in this study limited to gastric juices obtained in a uniform manner from patients and tested for a secretory depressant action on the stimulated dog's gastric pouch there is a pronounced difference in the incidence of such a gastric secretory depressant among the samples of achlorhydric juice from carcinomatous stomachs on the one hand and acid juices from carcinomatous stomachs or samples from patients not suffering from carcinoma of the stomach or pernicious anemia on the other hand, regardless of whether the juices of the latter groups contain free acid or not. Thus there is a suggestion that the hyposecretion and achlorhydria accompanying certain carcinomas of the stomach might be associated with an excess of a factor at least one property of which is an inhibitory action upon the secretion of gastric juice and liberation of free acid. Furthermore, the incidence, or 78 per cent, of the secretory depressant in the series of achlorhydric gastric juices from cancerous stomachs herein studied approximates the incidence or 89 per cent of the presence of such a depressant previously observed in achlorhydric juices from patients with pernicious anemia (2).

The 20 per cent incidence of the secretory depressant observed in the controls may be interpreted in one of two ways. First, it might be regarded as the incidence of non-specific depressant effects that follow injections of any

series of human gastric juices. In this event the much higher incidence of the depressant observed in achlorhydric juices from carcinomatous stomachs would suggest the presence of an abnormal substance with gastric secretory depressant properties in the latter stomachs. Second, if the incidence in the controls is regarded as evidence of a normal gastric secretory inhibiting mechanism, the greater incidence of the depressant found in the achlorhydric gastric juices from carcinomatous stomachs would suggest that with certain carcinomas of the stomach there is a hyperactivity of a normal secretory inhibiting mechanism.

SUMMARY

Samples of achlorhydric gastric juice from patients with carcinoma of the stomach were tested for a gastric secretory depressant action by intravenous injection into dogs with stimulated gastric pouches. Of 27 samples, 21 or 78 per cent, were found to exert an inhibitory action upon the pouch secretions as compared with similar effects obtained with approximately 20 per cent of 80 samples regarded as controls from patients not presenting carcinoma of the stomach or if so with normal or hyperchlorhydria.

The depressant factor was inactivated by boiling the juice containing it for 10 minutes.

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THE DIGITAL PLETHYSMOGRAPH AS A MEASURE OF THE PERIPHERAL CIRCULATION

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A PLETHYSMOGRAPH is defined (12) as, "An instrument for recording graphically the varying size of a part as determined by the fullness of its blood vessels" Plethysmographs are of two kinds depending upon the medium surrounding the part, that is, some use a liquid to transmit the volume changes and some use air The instruments are used for various purposes and are designated by various names, according to their use, such as the "Henderson cardiometer" for use on the heart, the "oncometer" for use on the spleen and kidneys, and, in this instance, the "digital plethysmograph" for use on the fingers and toes They are used to measure the slow volume changes such as occur with vasoconstriction or dilatation, and those rapidly induced such as are associated with the heart beat as measured by the Henderson cardiometer or by the digital plethysmograph

Plethysmographs have been used since early times for the study of physiological processes, particularly the physiology of muscle contraction and the study of circulation Clinically, they have been used in more recent years for the study of various diseases, especially those concerned with impairment of the peripheral circulation

The first plethysmographs of which illustrations can be found were devised by Jan Swammerdam (1637-1680), although one used by Francis Glisson probably antedated these Jan Swammerdam used his instrument to study muscle physiology, descriptions can be found in his works as edited by Boerhaave in *Biblia Naturæ* (1737) (13) He demonstrated that contraction of muscle was not due to an explosion within the muscle, as was then generally believed, and that contraction of somatic muscle produced only minor changes of volume of the muscle in question (Fig 1)

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The instrument devised by Swammerdam used air conduction acting on a droplet of water, the movement of the droplet of water acting as an index of volume change (Fig 1) Water offers considerable resistance to movement and does not respond to small volume changes or those rapidly induced A droplet of 95 per cent¹ alcohol used in the instrument to be described overcomes this difficulty and reduces the internal resistance of the instrument to a minimum (Fig 2)

Instruments are usually designed to meet specific requirements Although the one used by Swammerdam served his purposes very well, it is unsuited for clinical use The plethysmograph to be described was designed to meet the following requirements (1) to make measurements of volume changes of the fingers and toes where the first manifestations of vascular disease of the extremities usually occur, (2) for clinical studies, for which purpose the instrument should be simple, portable, and accurate, (3) to make permanent records for future comparisons This requires accurate calibration of the instrument

PRINCIPLE OF THE DIGITAL PLETHYSMOGRAPH

The principle of the instrument can best be understood from a study of the first model, and although a description has been published previously (6), a brief review will serve to give a clearer understanding of the new instrument

It consists of a 1 inch test tube (Fig 2) to which is fused a 1 cubic centimeter pipette graduated to 0.1 cubic centimeter and a bypass stopcock for adjustments The open end of the 1 inch tube is covered with a rubber dam with a hole sufficient to admit one finger The instrument is operated with the pipette in the horizontal position and when arranged as shown in Figure 2, the droplet of alcohol will

¹Alcohol has a slightly lower specific gravity viscosity and surface tension than water in addition its motion is not impeded by the film of grease which tends to collect on the recording tube when water is used

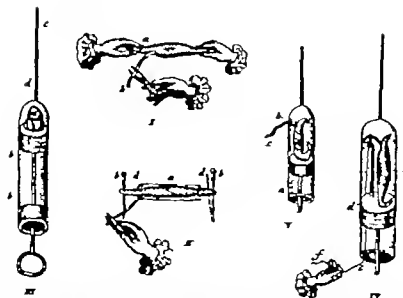


Fig. 1. This figure represents reproduction from Boerhaave's *De Arte Medica* and shows illustrations of the plethysmographs used by Jan Swammerdam. The text is literal translation from part of the original text to this figure. I, Muscle movement in the frog. *a*, The muscle tendons grasped by the fingers, *b* when the hanging nerve is touched, the muscle contraction draws the hands together. II Method showing thickening of muscle in contraction. Glass tube through which muscle is drawn, *b*, needles transpiercing tendons: *c*, the nerve touched, *d*, displacement of needles. III, Method showing that the heart occupies less space in contraction. *a*, Contracting heart is placed upon piston of glass tube; *b*, glass tube; *c*, ter droplet introduced into tube of siphon descends. *b* heart contraction, *d*, place in tube showing distance moved by droplet during time of descent. IV Method showing that contracted muscle takes up less space. Tube, *b*, muscle; *c*, silver thread through loop of which the nerve is passed; *d*, copper thread. *b* loop at top through which silver thread is drawn; *a*, stir droplet in siphon tube; *f*, hand stimulating nerve, muscle contracts, and droplet descends. V Another method of showing the above. *a*, Glass siphon, *b*, aperture drilled in the siphon; *c*, nerve drawn through the aperture.

oscillate with each heart beat the extent of which varies with differing circumstances as will be discussed later.

As the eye cannot visualize accurately the extent of this movement, the instrument has been adapted to photographic registration.

The original photographic instrument has been described (7) but a new improved one has been made with a new optical system. Figure 3 shows the instrument ready for use with optical registration of the movements of the droplet of alcohol. From a study of Figure 4,

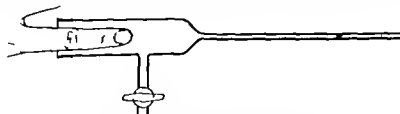


Fig. 2. A line drawing of the simplest form of digital plethysmograph. The droplet of 95 per cent alcohol is shown in black for illustrative purposes only. The rest of the diagram is self-explanatory.

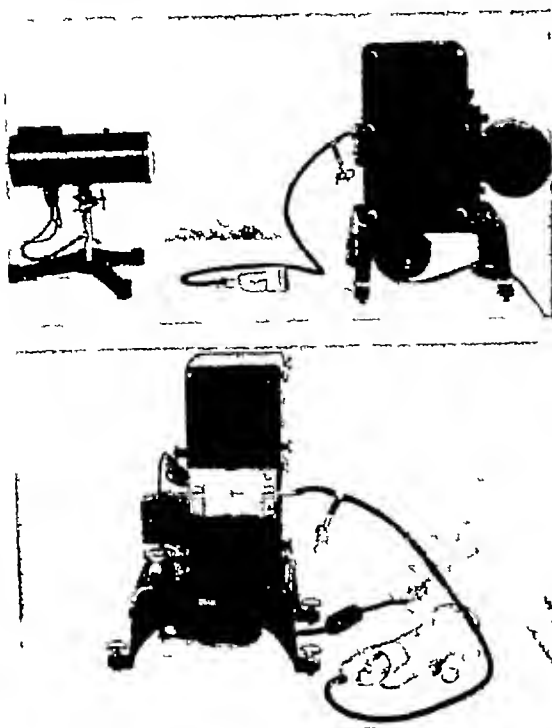


Fig 3 Two views of the new instrument. The upper view illustrates the general appearance of the instrument with its illuminating device. The thumb screws for removing the side plate for loading the instrument and the pick-up chamber for exposed paper which is removable and light proof are also shown. The lower photograph shows the instrument arranged for taking records. (By courtesy of the W. M. Welch Manufacturing Co.)

it is seen that the focal point of the pipette which acts as a plus cylinder, is behind the sensitive paper, but if alcohol is introduced, the focus of the pipette alcohol is on the sensitive paper and thus produces a very dark image on a gray background as shown in Figure 5. The graduations on the pipette face the sensitive paper and merely intercept the incoming light rays and appear as white lines (Fig 5). This automatically calibrates the digital plethysmograph so that volume changes to 0.002 cubic centimeter can be measured accurately.

Accuracy of the instrument. The volume of the finger is so great as compared with the finger volume change, being approximately 1300 to 1 in the normal individual and about 500 to 1 in patients with severe aortic regurgitation, that slight errors in application of the

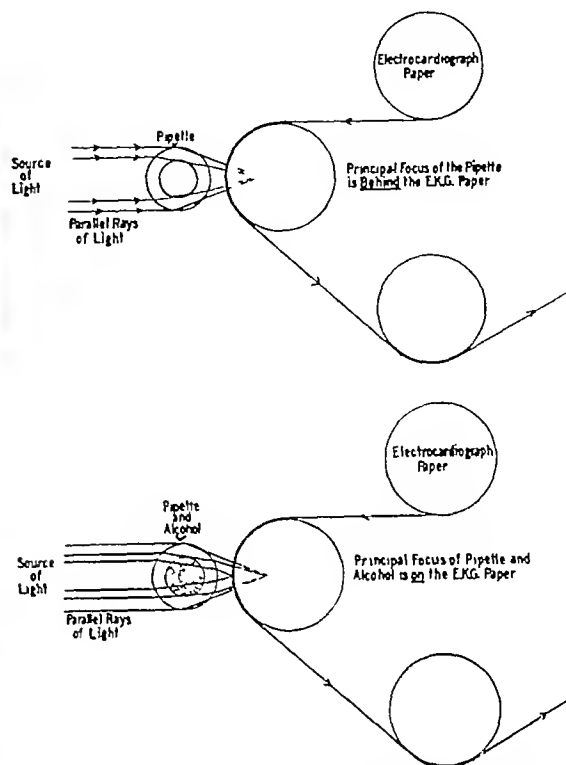


Fig 4 Optical system of the digital plethysmograph illustrating the simplicity of the recording camera.

finger chamber still give values within the range of experimental error of 0.002 cubic centimeter. This is borne out further by the following computations:

Deflection	Volume of finger		Deflection	Volume of finger
0.15	20		x	18
	x	=	0.135	
0.15	20		x	22
	x	=	0.16	

Either one of these figures lies within the range of experimental error. Records of finger volume changes can be made rapidly and accurately and the instrument is so simple that it does not require more than ordinary skill to operate. It can be used and good photographs obtained of clinical patients in partially lighted rooms such as hospital wards.

In order that the data offered in this report may not be misinterpreted and that the real purpose of the paper be understood, some of the results are anticipated in this brief introduction.

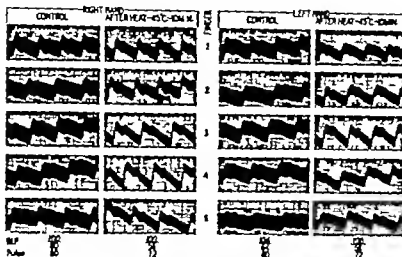


Fig. 5. Illustrative record of the finger volume changes in normal medical student. The black area represents the width of the recording droplet of ethyl alcohol and does not enter into the measurements. Measurements are made from the depression to the peak of the oscillations. The horizontal lines are projections of the graduations on the recording pipette, and the distance between any lines is one centimeter. The vasodilating effects of local heat are well illustrated in this record by the increased amplitude of the extensions.

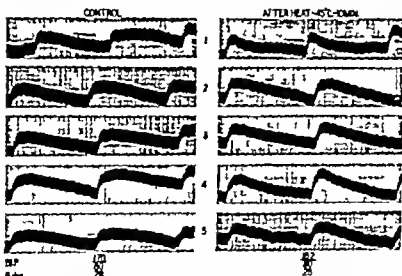


Fig. 6. This figure shows the effect of local heat on the finger volume changes in patient with complete heart block. Note that the control finger volume changes are about twice the normal, as shown in Figure 5. This is interpreted as due to the decreased stroke output of the heart to compensate for the slow heart rate. Local heat produced only small increases which suggests that vasodilatation is present which in part also compensates for the slow heart rate.

1. Certain computations from finger volume changes have been made and compared with results of measurement of the stroke out

put of the heart by other authors in normal patients, those with aortic regurgitation, and others with complete heart block. These com-

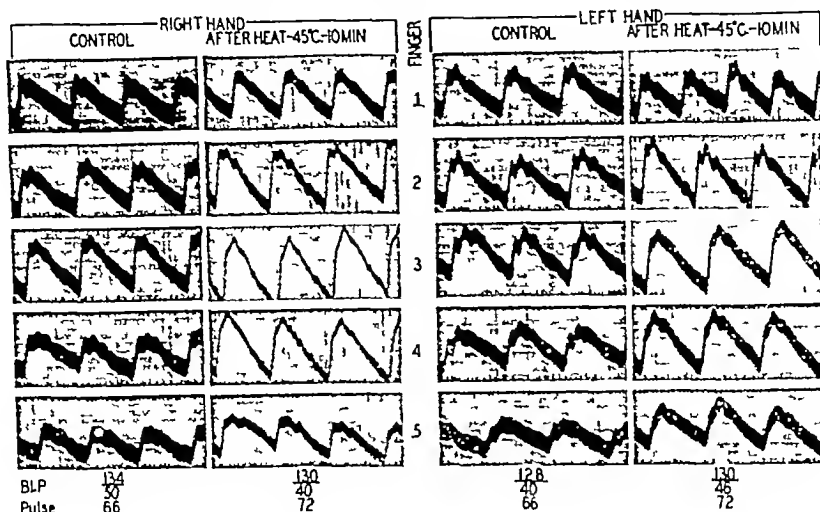


Fig 7 This figure illustrates the exaggerated finger volume changes one obtains from patients with severe aortic regurgitation. These changes are probably a reflection of the increased stroke output of the heart. Local heat produced a marked vasodilatation.

parisons are offered as part of the proof that the digital plethysmograph gives an accurate index of the peripheral circulation. I am not offering this as a new method for measuring the stroke output of the heart.

2 Further proof is shown by measurements of vasodilatation following the local heat, general heat, and nerve block. These procedures were chosen for illustration because it is generally accepted that they uniformly produce vasodilatation of the peripheral vessels in the absence of organic occlusion and if the blood pressure is maintained. Results of these studies coincide with the generally accepted views.

3 Finally, results of studies following experimental vascular occlusion and the vascular occlusion of disease are given. They check with what would be expected from the procedures applied as well as with the results of postmortem examination of the blood vessels.

The purpose of this paper is not so much to demonstrate the quantitative or qualitative nature of these studies, but to offer data on the value of this instrument and to present some of the views of the author regarding the interpretation of the results.

RESULTS OF STUDIES

Normals The finger volume changes vary with a number of circumstances, but at rest

the usual response from the third finger is from 01 to 02 cubic centimeter as shown in Figure 5. This response is associated with the heart beat and its extent is influenced mainly by factors which maintain blood pressure, the most important of which are the volume of the blood, the viscosity of the blood, the force and rate of the heart, the elasticity of the blood vessels, and the peripheral resistance. It is felt that the finger volume change associated with the heart beat affords a simple method of measuring the peripheral circulation. It is well recognized that some tissues receive more blood per gram of weight than others, but if it is assumed that the fingers receive an average amount of blood in proportion to their volume, a rough estimation of the stroke output of the heart may be computed as follows: mass of the finger is to the mass of the body as the finger volume change is to the stroke output of the heart. If actual measurements are substituted, the results are shown in Table I.

These figures are close to those obtained by other methods. This should not be construed to mean that it is offered as a measure of cardiac stroke outputs, but is merely inserted to show that the finger volume changes may serve as an index of the peripheral circulation. Further proof of this contention is more easily

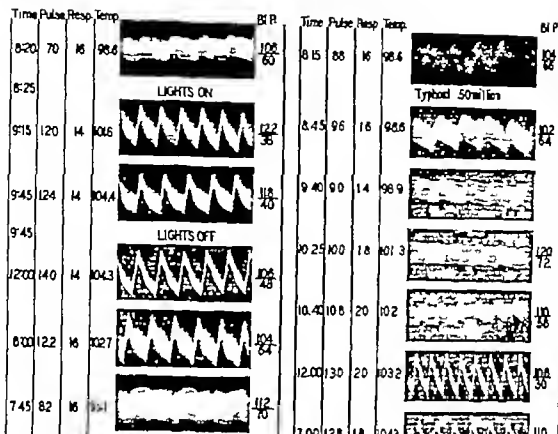


Fig. 8. The effects of artificial fever from external heat on the finger volume changes as illustrated. The markedly increased amplitude is interpreted as due to increased peripheral circulation from vasodilatation and increased stroke output of the heart.

shown in patients with an exaggerated response such as complete heart block with slow heart rate, and aortic regurgitation.

Complete heart block. Various investigators agree that the stroke output of the heart is increased in complete heart block, although minute output is usually normal. The results of some of the studies found in the literature are in Table II.

In this study computations of the systolic output and the minute output of the heart were made from the finger volume changes in one patient, a white male, aged 56 years, weight, 89 kilograms, who had a complete heart block for which no definite etiological basis could be found (Table III).

Fig. 9. This illustration shows the effect of artificial fever from foreign protein on the finger volume changes of the third finger of the left hand. Note the decreased amplitude associated with chill followed by an increase. This is interpreted as primary vasoconstriction followed by vasodilatation.

The test was repeated and the figures shown in Table IV obtained. These results in all probability are only a rough index of the systolic output and minute output of the heart in complete block, but they are in keeping with results obtained by other methods, and further

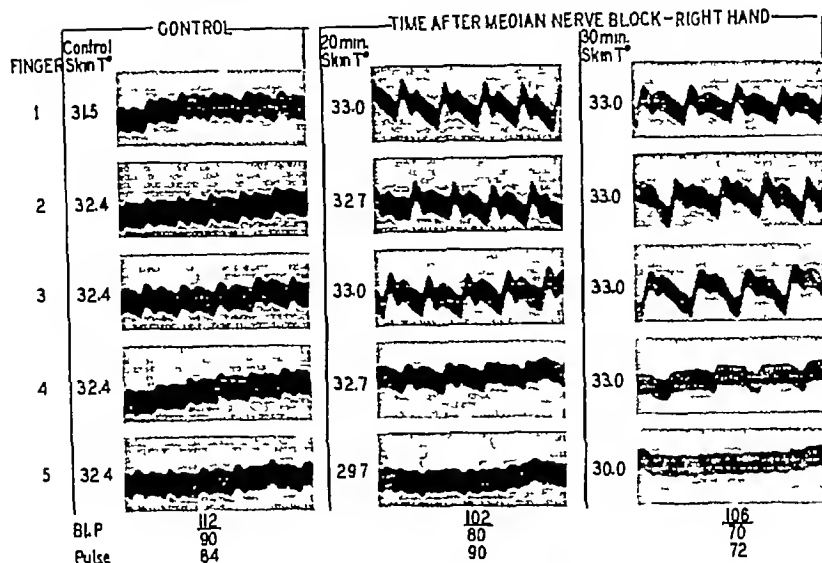


Fig 10 The finger volume changes before and after median nerve block at the wrist, with novocain. Note the marked increased amplitude in the fingers innervated by the median nerve and a decrease in the fifth finger. These results are interpreted as vasodilatation in the fingers innervated by the median nerve from loss of vasoconstrictor tone from the paralysis.

TABLE I — RESULTS OF AUTHOR'S EXPERIMENT

Finger	Right Hand			Left Hand		
	Mass of finger	Finger volume change	Systolic output	Mass of finger	Finger volume change	Systolic output
1	20	023	74.9	22	022	65
2	21	017	53	19	017	58
3	25	026	67.5	22	021	62
4	20	023	74.9	18	019	69
5	15	017	73.5	13	010	50
Average	20.2	0212	68.4	18.6	0176	61.5

This experiment was performed on a normal interne weighing 65 kilograms, pulse 60, minute output right hand 4.104, left hand 3.690 cubic centimeters.

TABLE III — COMPUTATIONS OF SYSTOLIC AND MINUTE OUTPUT OF HEART

Date	Finger	Volume of finger in c.cm.	Finger volume change in c.cm.	Systolic output in c.cm.	Heart rate	Minute output in liters
4-2-37	1	21	04	169		
	2	27	034	112		
	3	28	038	121		
	4	4	034	126		
	5	16	024	133		
Average		10.2	032	132	6	3.43

TABLE II — RESULTS OF EXPERIMENTS FOUND IN LITERATURE

Author	Case	Systolic output in c.cm.	Minute output in liters
Alt Walker and Smith	1	125	5.4
Alt Walker and Smith	2	154	4.8
Ellis and Weiss	1	139 123	5.09 4.92
Ellis and Weiss	2	156 147	5.62 5.28
Ellis and Weiss	3	142 141	4.55 4.60
Ellis and Weiss	4	200 156	5.82 4.69
Liljestrand and Zander	1	123	4.5

TABLE IV — RESULTS OF REPEATED TEST

Date	Finger	Volume of finger in c.cm.	Finger volume change in c.cm.	Systolic output in c.cm.	Heart rate	Minute output in liters
4-10-37	1	21	024	102		
	2	27	027	89		
	3	28	036	114		
	4	24	038	141		
	5	16	023	128		
Average		10.2	0.96	115	28	3.22

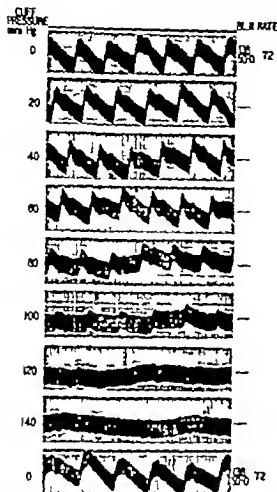


Fig. 7. The effect of artificial vascular occlusion on the finger pulse volume changes. A blood pressure cuff was applied just above the cubital space and records were taken at various pressures. Note that the amplitude of the finger pulse changes did not decrease much until pressures greater than the diastolic pressure were used. The finger pulse changes were abolished when the systolic pressure was reached and returned to the control level when the cuff pressure was released.

indicate that this method offers a good index of the peripheral circulation.

Aortic regurgitation. The presence of aortic regurgitation is reflected in the peripheral circulation by well recognized signs such as Corrigan's pulse, capillary pulse, and increased pulse pressure. The magnitude of these signs seems related to the degree of regurgitation.

Wiggers has demonstrated on experimental animals that the magnitude of the backflow

TABLE V.—COMPUTATIONS OF SYSTOLIC OUTPUT

Finger	Amount of Supply in cc.	Finger volume change in cc.	Systolic output
	70	844	
		64	
	77	655	
	80	57	
		66	
Average	75.8	598	13 cc.

depends mainly on the size of the leak and can range from 5 per cent with small leaks to 50 per cent or more when the cusps are rendered totally deficient. There is also an increased systolic discharge and more complete emptying of the ventricle immediately after production of large aortic leaks in experimental animals. As a result of compensatory mechanisms the net systolic discharge and the minute volume tend to approximate normal again, although clinical results appear confused by different gasometric procedures and also by the fact that other valvular lesions often co-exist.

From the point of view of this study the peripheral manifestations of aortic regurgitation are reflected in the pulse volume changes. The amplitude of these changes seems related to the severity of the aortic leak. Figure 7 shows a record from a patient with severe aortic regurgitation. Computations of systolic output are given in Table V.

This patient weighed 62.7 kilograms, had mitral stenosis and regurgitation, and aortic regurgitation on a rheumatic basis. This case was the most severe of the series. Studies on other patients with luetic aortic regurgitation were similar to the findings on this patient. The magnitude of the response apparently varied with that of the regurgitation.

Effect of local heat. Local heat has been used since early times for the treatment of disease and the alleviation of pain. It is universally accepted that at least one of the effects of local heat in the absence of organic peripheral vascular pathology provided blood pressure is maintained, is a local vascular dilatation. Local vasodilatation from heat to the hand manifests itself in several ways, such as a sub-

checked after death gave results consistent with the procedures applied or the postmortem findings in the peripheral vessels

Finally, it can be stated that the work herein is not entirely new. Erlanger and Hooker, as early as 1904, investigated some of the fundamental principles of this study and used a Van Kreis flame-tachygraph to measure arm volume changes. The authors probably recognized the possibility of this method of measuring the peripheral circulation, but their instruments were cumbersome and inadequate. Grollman also gives a discussion on the relation of the cardiac output to the arterial pressure which has some bearing on this report.

CONCLUSIONS

The data presented provide further experimental evidence and confirm earlier conclusions that the digital plethysmograph offers an accurate means of investigating the efficiency of the peripheral circulation and may be used to differentiate organic from functional occlusion of the peripheral vessels.

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discussion of results of studies of the circulation upon 21 patients having Raynaud's symptoms. Four of the patients had operations upon the sympathetic nervous system to relieve the symptoms. The results of these studies on the treatment of Raynaud's disease will be reported in detail in a succeeding article in which the digital plethysmograph was used to obtain evidence upon which to base many of the conclusions drawn in that study.

Effect of experimental occlusion of the peripheral vessels. One of the criticisms frequently encountered with regard to this instrument is that the cuff of the plethysmograph chamber exerts a constricting influence sufficient to interfere with the accuracy of the results. As a check the following experiment was done. A blood pressure cuff was applied to the arm, and records of the fingers of the same extremity were taken during various degrees of constriction of the arm. Figure 11 illustrates the changes observed. It is noteworthy that the finger volume changes are not appreciably decreased until the pressure in the cuff is above the diastolic pressure. These results indicate that the criticism is not justified by the facts.

Effect of occlusive vascular disease on the finger volume changes. One patient with Buerger's disease and one with multiple arterial emboli were studied in detail during life, and the studies on the peripheral circulation made by means of the plethysmograph were correlated with the findings in the peripheral vessels after death. Although these results will be reported in detail later it can be said that in occlusive vascular disease the results of study with the plethysmograph offer an accurate index of the degree of vascular occlusion.

EVALUATION OF STUDY

In this study an attempt has been made to demonstrate that the digital plethysmograph offers a simple and accurate means of making permanent calibrated records of the finger volume changes in various clinical conditions.

It is thought that the finger volume changes offer an index of the peripheral circulation under normal environmental conditions in the absence of organic occlusive vascular changes provided the blood pressure is maintained. It

is predicated that under normal conditions, in normal subjects, or in patients with complete heart block and aortic regurgitation, the output of the heart is reflected in the peripheral vessels. Computations of the stroke output of the heart from the finger volume changes gave figures comparable to those obtained by others who used the gasometric methods.

It is recognized that the interpretation of the finger volume changes is controversial. The author believes however that the finger volume changes are a measure of the pulsatile flow of blood.

It is a generally accepted fact that fluids are not compressible or are to a very minor degree only. When one considers that the circulating fluids or soft tissues are mainly fluids, it can be assumed they are not compressible or are only to a minor degree. They therefore will transmit volume changes accurately in the vascular system.

Due to the elasticity of the vascular system and the physiological action of the heart and blood vessels of the human being the blood flow through the blood vessels of the fingers occurs in a pulsatile and non-pulsatile manner. The measurement of the flow then resolves itself into the measurement of the pulsatile and non-pulsatile flow of blood. The non-pulsatile flow of blood cannot be measured by this means, but the pulsatile flow can be measured very accurately. The pulsatile flow is measured in systole. Since systole is very short as compared with diastole, the error from failure to measure the non-pulsatile flow of blood is very small and acts more or less as a constant for normal heart rates but may introduce a larger error from abnormally fast heart rates. For practical purposes this does not interfere with a qualitative estimation of the peripheral circulation.

This method can also be used to measure the effects of vasoconstrictor and vasodilator agents on the peripheral circulation, and illustrations of the effects of local heat, general heat, artificial fever and median nerve block have been shown. The results of these studies corroborate the generally accepted ideas.

In addition experimental occlusion of the peripheral vessels as well as organic occlusion

by insertion of the finger into the rectum will often make the degree of true pelvic tenderness difficult to evaluate. On the other hand, the finding of a mass or of induration is a positive sign. Abdominal puncture is frequently of crucial aid in establishing the presence or absence of infection of the peritoneal cavity, and the extent of infection when present. The subject of abdominal puncture in the diagnosis of acute intraperitoneal disease has been dealt with in detail in a previous communication (4) and will not be discussed further in this place.

Pre-operative treatment The choice of time for operation. Intravenous infusion is so generally used at the present time that any comment on its value would be superfluous. We do not usually operate on admission in acutely ill, dehydrated patients who have been sick for 2 days or longer. These patients require continuous observation since there is no definite assurance that a peritoneal infection, if present, will subside upon rest and supportive treatment. We have no rule of thumb, and attempt to make the decision in each case in accordance with clinical manifestations. In general we would say that it is safer in such patients to allow at least several hours for supportive treatment before proceeding with operation. Like others we make an exception to this general plan in infants or young children in whom there appears to be but slight tendency toward a walling off of a peritoneal infection.

In appendiceal abscess it is usually safer, in our opinion, to defer operation until the acute inflammatory process has subsided at least in part. A close watch is kept on the temperature, pulse, and abdomen, and frequent blood counts are used as aids in determining if subsidence is occurring. At the outset, when patients first come under observation, intravenous fluids are administered. Bland fluids by mouth are given only when there is reasonable assurance that they will be well tolerated. Enemas and frequent abdominal examinations are interdicted. We have never observed a patient presenting a palpable mass due to appendiceal abscess in whom the inflammatory signs did not subside under this management.

Anesthesia A variety of anesthetic agents have been employed, the choice depending on

the problem presented by the individual case. In order of frequency they were avertin and nitrous oxide with or without ether, nitrous oxide ether, ether, spinal, and local. Previous studies in avertin anesthesia (2) led us to employ this agent in most cases. Spinal anesthesia was chosen for obese patients who were not gravely ill and who presented no pronounced evidences of arteriosclerosis, myocardial disease, or hypertension.

Incision Emphasizing the fact that this contribution deals solely with the severer forms of acute appendicitis, we wish to state emphatically that we do not agree with those who advocate a routine incision which is usually the McBurney. It is our contention that an incision must fulfill two requirements: (1) The size should be such as to allow a full view of the lesion, (2) the site should be over the assumed or known location of the lesion. We are guided as to the site of incision by the situation of localized tenderness on palpation, or by the situation of a mass. The latter is felt for when the patient is under anesthesia even if not noted to exist in the pre-operative period. We employ three types of incision: the rectus splitting, an incision which we term the "vertical pararectus," and the McBurney. By the vertical pararectus incision we mean an incision made lateral to the rectus sheath in a vertical direction through the oblique and transversus abdominis muscles, transversalis fascia, and peritoneum.

Operative procedures The objective is a carefully executed operation under full visualization. The general principles of technique of operation can be stated briefly. The abdominal wall is protected by pads. Suction is started immediately after the peritoneal cavity is opened, if any free fluid is encountered. A smear and culture are taken. If free, the omentum is drawn over any visible loops of small intestine. The latter, with or without omentum, are packed off with warm, moist pads. The only small intestine to be seen in the operative field should be limited to the terminal ileum. The cecum is exposed, and the base of the appendix is located by following the anterior longitudinal band. A catgut sling placed about the base of the appendix by means of an aneurism needle provides an ex-

THE SEVERER FORMS OF ACUTE APPENDICITIS WITH SPECIAL REFERENCE TO THE TREATMENT OF APPENDICEAL ABSCESS

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EDUCATION of the laity and surgical management are generally discussed jointly in contributions dealing with the appendicitis problem. Mortality and morbidity statistics have been related to the time at which patients were first examined by physicians to the question of administration of cathartics, and to other non-surgical factors. Unquestionably early operation and the omission of catharsis lower greatly the mortality of appendicitis. However there is surely no justification for the assumption that the problem would be solved by education of the laity. Questions in diagnosis and surgical management would still remain in no small proportion of cases. These problems should be dealt with separately in order to invite more thought devoted specifically to the subject of improvement of surgical treatment. This article comprises such a separate consideration of the subject.

In a former contribution (1) we dealt with the factors contributing to a reduction in mortality in the more serious forms of acute appendicitis. As a result of adhering to certain principles in general management and operative technique there occurred and was reported a low mortality in the three year period from 1931 to 1934. From an analysis of our personal experiences from 1931 to 1939, upon which the present paper is based, we are convinced that death should rarely follow operations for acute phlegmonous or gangrenous appendicitis, appendicitis with local peritonitis, or appendicitis with abscess. This view is based on the statistics shown in Table I, which is a summary of the results of operations performed by us on ward service and in private practice from 1931 to 1939.

From The Mount Sinai Hospital
Read before the Surgical Section of the New York Academy
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TABLE I.—RESULTS OF OPERATION

Variety of Appendicitis	Cases	Deaths	Mortality per cent
Acute phlegmonous or gangrenous	41		0.7
Acute, with abscess	40		
Acute, with local peritonitis	7		
Acute, with diffuse peritonitis	3	3	3
Total		4	1.8

Of the fatal cases, three occurred in patients in whom diffuse peritonitis existed at the time of operation. The fourth death was in a 73 year old man who had an appendicectomy with drainage for acute gangrenous appendicitis. He died on the seventh postoperative day with the symptoms and signs of pneumonia. A postmortem examination was not performed.

Diagnostic features. The symptomatology of acute appendicitis is too well known to require any comment here. Only rarely in our experience is the history atypical. Palpation of the abdominal wall determines the site and degree of tenderness and spasticity and the presence or absence of a mass. It is the most important guide to the location of the appendiceal lesion. Such palpation must be performed gently. The attempt to induce so-called rebound tenderness is a practice we condemn. The sudden release of the abdominal wall causes the patient unnecessary pain may be positive in the absence of peritonitis, adds no information of importance and conceivably spreads infection. At times children or apprehensive adults are told to palpate their own abdomen in order to elicit point tenderness. Useful information has been obtained on not a few occasions. Considerable reliance is placed by many on the finding of tenderness on rectal or pelvic examination. There are often differences of interpretation between various examiners. The pain induced

tonitis, we have relatively little to offer. On the other hand, we propose to show that recovery should follow operation for appendiceal abscess in the great majority of instances. Although the number of cases upon which we have operated is not very large, we feel that the evidence we shall submit is conclusive.

Our special interest in the problem of appendiceal abscess dates from 1931, when, as the result of an analysis which was made of operations for appendiceal abscess, we found that the operative mortality was not substantially lower than that after operations for acute appendicitis with diffuse peritonitis. A study of autopsied cases revealed the fact that peritonitis, which did not exist at the time of operation, was the usual cause of death. It was obvious that extension of infection from the appendiceal abscess was due to errors in management and in technique, and therefore was avoidable. In 1934 (1) we reported a reduction in the mortality of operations for appendiceal abscess over a 3 year period, to 6.4 per cent. These operations were performed by all of the staff on one of the surgical services. We report now on 40 cases of appendiceal abscess personally operated upon by us in the years 1931 to 1939 with no mortality. No cases have been omitted.

Operative procedures. The general subject of operative technique has been discussed earlier in the paper, but some additional remarks on the operative technique of appendiceal abscess appear to be warranted. The peritoneal cavity is usually opened directly over the mass, and a temporary protective packing is put in place. As more of the mass is exposed, additional packings are inserted in order completely to wall off the mass from the peritoneal cavity. The abscess remains undisturbed until this walling off is so satisfactory that none of the peritoneal contents can be seen and the dome of the abscess is fully visualized. The protective packings are not to be disturbed during the remainder of this operation, they may be added to because walling off is found to be incomplete, but should never be removed. The abscess is entered with a blunt instrument, usually a Mayo scissors, at a point as distant as possible from a presenting loop of bowel (if any), and at a site at which a plane of cleavage

appears to exist. As soon as pus is encountered it is immediately removed with the suction tip. The plane of cleavage inside the wall of the abscess cavity is carefully developed. The suction tip often serves as a useful instrument for this purpose and of course offers the advantage of removing pus as it appears. Flexible retractors of different widths are employed in exposing the cavity, being bent at appropriate angles and inserted progressively deeper as the abscess is opened up. A sterile light inserted into the cavity aids in visualization in some cases. The objective of the operation we practice is a complete opening up of the abscess cavity or cavities, including secondary loculations, under visualization, in a field in which the peritoneal cavity is completely packed off. Concerning the latter, the appearance of a suspicious place outside the abscess cavity in which a loop of intestine might appear, and of course the actual appearance of any intraperitoneal structure at such a place, should lead to immediate interruption of operation on the abscess and the placement of additional packing with previously unused instruments.

According to an apparently widely held view, simple drainage of an appendiceal abscess is safer than the additional step of removal of the appendix when the appendix is not readily accessible. This view is correct undoubtedly in some instances, and we do not insist upon appendectomy in all cases. In general, however, we regard such an operation to be not only incomplete but also potentially dangerous, because of suppurative foci which may be left *in situ*. If the operative exposure is carried out carefully in the manner which has been described, the removal of the appendix can be accomplished in most instances and can be carried out safely. In our experience, disappearance of the appendix by sloughing is rare. It is of interest to note that we found intact appendices in 3 patients previously subjected to drainage of appendiceal abscess, and reported to have had "disintegration of the appendix." We wish to stress the potential danger in leaving the appendix behind. First, there is the obvious danger of sepsis in one form or another derived from the appendix itself. Second, there is perhaps even greater

cellent guide as well as retractor and permits return of the cecum to the peritoneal cavity before the delivery of the appendix is begun. Delivery of the appendix is usually performed entirely with instruments, and we find resort to the use of the finger rarely necessary. A curved Mayo scissors and a periosteal elevator are useful instruments for the dissection. Should the fingers be employed for some particular purpose, the glove is immediately changed. Indeed, gloves should be changed as often as they become intentionally or inadvertently contaminated. Traction on the appendix must be gentle and is aided by the placing of Allis clamps or small artery forceps on the mesentery. After the mesentery is ligated the base of the appendix is ligated with a chromic ligature. One of us (H.N.) has devised an instrument which is termed an appendix roller. This instrument consists of two circular ridged pieces of metal which roll around straight metal pins attached at right angles to the jaws of an artery clamp. The instrument is useful for the emptying of the proximal portion of the appendix before it is clamped, thus preventing spillage when the appendix is severed. The base of the appendix is cut across with a carbolyzed knife or electrocautery and the stump is thoroughly treated with carbolic acid or the coagulation current. The technique of operation for appendiceal abscess will be separately discussed.

Drainage. The method of drainage which we employ will be discussed in connection with the subject of appendiceal abscess. Our indications for drainage, aside from cases of appendiceal abscess, are (1) a localized collection of frankly purulent fluid (2) purulent exudate extending decidedly beyond the limits of the appendix (3) an infected appendiceal bed, particularly when such an infected area is in close contact with the retroperitoneal tissues (4) a doubtful appendiceal stump.

Postoperative management. In seriously ill patients, the intravenous infusion of glucose and saline, which had been started before and continued during operation is maintained after operation. It can, if needed, be continued many days by using the drip method and changing the needle every 24 hours in order to reduce the likelihood of a phlebitis. An in-

dwelling Levin tube is useful in combatting gastric retention and related postoperative distention. It is passed immediately if there is nausea or vomiting. Repeated vomiting is not awaited, for it usually represents overflow from gastric retention rather than effective emptying of the stomach. Adequate amounts of opiates are administered. Cathartics are not employed. In our opinion, intentional obstruction in the early postoperative period is due to angulation of the intestine by fibrinous exudate. The latter will be absorbed, in all probability. Therefore we take a very conservative attitude as to the indications for operation for this lesion. The course of any patient displaying manifestations of obstruction is checked up by frequent roentgen examinations of the abdomen. In none of our cases was it necessary to operate for intestinal obstruction in the postoperative phase.

In the postoperative management it is very important to search for and provide adequate drainage of complicating suppurative foci. Therefore daily (or more frequent) examinations should be made of regions in which complicating abscesses are apt to develop in the postoperative period (subphrenic, pelvic, left abdominal) in order to recognize promptly their evolution. When the postoperative course is not satisfactory we assume that a complication exists in or about the peritoneal cavity related to the field of operation. Therefore such a complication is searched for unremittingly. Even when an obvious distant lesion, such as a pneumonitis, may seem to explain the complication, examination of the abdomen remains an essential step. Reference is made to a study which has shown that suppuration is the most common cause of death after laparotomy for any infective intraperitoneal lesion (4).

THE PROBLEM OF APPENDICEAL ABSCESS

By appendiceal abscess we mean a circumscribed collection of pus in the appendiceal region walled off from the free peritoneal cavity by omentum or intestines, or both. Acute appendicitis with abscess and acute appendicitis with diffuse peritonitis remain varieties which still comprise problems for solution. Concerning the group of cases of diffuse peri-

4 deaths, a mortality of 18 per cent. The mortality was 0.7 per cent in 142 cases of acute phlegmonous or gangrenous appendicitis, and 23 per cent in 13 cases of acute appendicitis with diffuse peritonitis. Of the 4 deaths, diffuse peritonitis was present at the time of operation in 3 patients. There were no deaths in 40 cases of acute appendicitis with abscess, or in 17 cases of acute appendicitis with local peritonitis.

The low mortality (with the exception of cases of diffuse peritonitis) is attributed essentially to certain principles in operative technique, and in general management before and after operation. Some aspects of diagnosis are stressed, with special reference to abdominal puncture. The choice of time for operation in acutely ill, dehydrated adults is discussed, with emphasis on deferred operation in the presence of *proved* diffuse peritonitis (proved by abdominal puncture).

Avertin with the addition of inhalation anesthesia was employed in most cases. Incisions were not made in a routine manner. They were placed over the known or assumed site of the lesion and were large enough for its complete exposure. A special incision is described to meet particular requirements. Full visualization and isolation of the lesion is a basic feature of the operative technique. Release and delivery of the appendix by "no touch" technique is described and advocated. The indications for drainage are given. In the postoperative management, particular reference is made to the desirability of search for and early recognition of complicating intra-abdominal suppurative foci.

Separate consideration is given to the subject of appendiceal abscess. The reasons for the absence of mortality are analyzed and set forth. Some of the important features of management which are discussed and on which the results are thought to be based are (1) Deferred operation in the early stages of appendiceal abscess and operation when the acute manifestations have subsided, (2) at operation, complete exposure and walling off of the abscess by packs, (3) entry of the abscess through a plane of cleavage, which is developed progressively, (4) complete evacuation of all recesses of the abscess or abscesses, (5) meticulous "no touch" technique, (6) removal of the appendix in most instances, (7) drainage of all recesses of the abscess cavity or cavities by gauze packs, and not by tube or rubber dam. In the postoperative course the absence of profuse and malodorous discharge and of infection of the abdominal wall following the technique which is advocated, is pointed out. Postoperative complications were few in number. A transient fistula to the open stump of the appendix was present in 1 case. Postoperative incisional hernia did not occur in 31 cases which were followed from 1 to 8 years.

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danger of sepsis from one or more abscesses adjacent to the appendix which may be left behind in simple drainage of appendiceal abscess. Such additional abscesses may not be encountered except at the time that the appendix is being freed. On some occasions we have opened into two or three periappendiceal abscesses in addition to the one entered primarily. Finally we know of a number of antopics after simple drainage of appendiceal abscess in which death was due to sepsis from additional abscesses about the appendix which had not been opened or from the suppurative appendiceal lesion itself.

Drainage. The assumption that a profuse and oftentimes foul discharge is inevitable after the drainage of an appendiceal abscess is erroneous. Such postoperative discharge follows incorrect drainage of the abscess cavity. In our opinion and experience, drainage by gauze placed as a packing into the abscess cavity is rarely followed either by profuse or by foul discharge. A percutaneous gauze drain does not suffice. Gauze strips should be used. Under full visualization they should be packed snugly into all recesses of the abscess cavity from the bottom up. The packings are surrounded by sheets of rubber dam in order to separate the gauze from the contents of the peritoneal cavity. The placement of the rubber dam is the last step before closure of the peritoneal cavity the original protective walling off packings being withdrawn as the rubber dam is put in place. If omentum is available, it is drawn over the operative region.

We object to tube drainage for the reasons given in our previous paper: (1) no assurance that the tube remains where it is placed (2) irregular collapse of the walls of the abscess cavity around and beyond the tube with consequent tendency toward pocketing (3) the postmortem evidence of residual abscesses about tube drains (4) the commonly noted postoperative foul discharge and sloughing.

It has been stated that gauze drainage in the peritoneal cavity leads to peritoneal adhesions. This has not been our experience. A follow up of our cases does not point to evidence of late intestinal obstruction.

Postoperative management. The drains are not shortened until loosened by discharge.

This discharge is neither profuse nor foul. Rubber dams were out on an average on the seventh postoperative day and the packings on the tenth day. The abdominal wounds are rarely infected. After all the drains are out, there is usually left a clean, granulating cavity which is lightly repacked. Occasionally because of some retention behind the packings, it is necessary to insert a small, soft rubber tube. This was done in 7 of the patients.

The temperature was usually normal by the sixth postoperative day. There was a secondary rise in temperature in 5 patients. In 1 case this was due to an acute cholecystitis. The cause of the rise in temperature in the 4 other cases was not known. There was a prolonged period of fever in 3 cases. In 2 patients this was due to a bronchopneumonia and in the third patient to a pelvic abscess.

Intravenous glucose and saline infusions were given in 10 patients for an average period of 50 hours. Two patients required the use of an indwelling Levin tube for a period of a week. An enema or colon irrigation was usually given on the fourth or fifth day after operation.

The postoperative complications were as follows: pneumonia, 3 cases; pelvic abscess, 1 case; paralytic ileus, 1 case; intestinal fistula for 1 week, 1 case; acute cholecystitis, 1 case; auricular fibrillation, 1 case; respiratory depression due to avertin, 1 case; exhaustion psychosis, 1 case. The average time of discharge from the hospital was the twenty first postoperative day.

There is now a follow-up on 31 of the appendiceal abscess cases ranging from 1 to 8 years. In none of them was a postoperative (incisional) hernia noted. This observation is of special interest because the abscess cavities were widely packed in these cases. We assume that the reason postoperative hernias did not occur was because there was no gross infection or sloughing following drainage.

SUMMARY

This paper deals solely with the surgical aspects of the severer forms of acute appendicitis. In a series of 213 cases in which patients were operated upon by us in private and in ward practice in a period of 8 years, there were

TABLE I —SERUM POTASSIUM OF CADAVER CARDIAC BLOOD OBTAINED AT AUTOPSY

Hospital No. Date of death	Initials, sex and age	Principal autopsy findings	Serum potassium as milligrams per cent
534998 7-3-38	J M M 27	Rheumatic endocarditis	54.7
531679 3-31-38	T G M 45	Carcinoma of stomach duodenojejunostomy	50.2
37890 5-10-38	J G F 31	Tuberculous leptomenigitis	60.9
37862 8-18-38	C V M 57	Glioblastoma of cerebral hemisphere	64.5
547187 5-23-38	M H F 50	Hyperplasia of thyroid with hyperthyroidism	70.0
538189 4-12-38	M L F 56	Congenital malformation of heart cardiac hypertrophy and dilatation	70.4
11647 4-6-38	H LaC M 69	Multiple fractures of skull	72.0
37736 4-25-38	C O K F 35	Abscesses of cerebellum	73.5
487166 7-22-38	A R M 53	Cardiac hypertrophy and dilatation clinical diagnosis hypertension uremia	76.6
522385 4-18-38	L H F 41	Chronic myeloid leukemia	77.4
389643 4-19-38	M F F 35	Carcinoma of female mammary gland with multiple metastases to lymph nodes	77.7
548449 4-27-38	I B F 27	Placenta previa cesarean section	80.8
545832 4-21-38	G H M 66	Carcinoma of stomach partial gastrectomy	87.2
433652 3-2-38	R R M 62	Subacute glomerulonephritis pneumonia clinical diagnosis hypertension uremia	97.0
552683 6-21-38	B T M 56	Acute gangrenous appendicitis with peritonitis	98.0
367436 8-14-38	W R M 65	Carcinoma of sigmoid resection of colon	98.3
451845 4-30-38	H R F 48	Lymphosarcoma of lymph nodes second ary lymphosarcoma of dura mater multiple abscesses laminectomy resection of tumor	98.9
250743 4-27-38	S F F 64	Arterial nephrosclerosis clinical diagnosis uremia	110.0
281444 5-18-38	W H M 13	Rheumatic endocarditis	118.0
37623 5-9-38	M S F 52	Meningioma olfactory groove operation bilateral cervical sympathectomy	118.0
520112 1-31-38	C M F 40	Subacute bacterial endocarditis due to gram positive coccus splenectomy	118.6
543474 4-4-38	J S M 67	Carcinoma of colon colostomy resection of carcinoma of colon	128.0
552248 6-2-38	A E F 58	Carcinoma of stomach	141.0
204654 1-3-38	R R F 31	Rheumatic endocarditis	160.0
540302 5-25-38	K S M 68	Acute splenic tumor clinical cause of death cerebral thrombosis	166.0
549147 4-8-38	A B F 63	Venous angioma temporal lobe	150.0
544416 4-1-38	R M M 68	Carcinoma of kidney pneumonia	180.0

TABLE II —PLASMA POTASSIUM OF HUMAN BLOOD*

Number of samples analyzed	Source of sample	Plasma potassium expressed as			
		Milligrams per cent		Millimols per liter	
		Average	Range	Average	Range
73	Venous blood from normal young adults	17.2	13.5-21.5	4.4	3.5-5.5
13	Cardiac blood removed at death	29.7	24.0-38.0	7.6	6.1-9.7
27	Cardiac blood removed at autopsy	101.0	54.7-180.0	25.8	14.0-46.0

*Centrifuged at 2000 r.p.m. for 1 hour after which the plasma or serum was immediately separated from the cells.
The average time of separating the serum from the cells after death was 31.5 hours.
The figure for each determination represents the mean of 2 aliquot samples.

TABLE III —THE EFFECT OF ADDING AMMONIA TO BLOOD ON POTASSIUM DIFFUSION TEMPERATURE 38° C

Date	Time in hours from phlebotomy	Potassium as milligrams per cent in plasma of citrated blood		
		Control	Ammoniated blood	Difference between specimens
3-18-39	0	20.9*		
	2	19.6	30.6	11.0
	4	20.0	29.0	9.0
	6	20.3	31.7	11.4
3-10-39	8	21.9	33.2	11.3
	15	23.0	40.0	17.0
	18	27.2	43.9	16.7
3-20-39	23	30.9	52.8	21.9
	31	40.4	55.7	15.3
3-21-39	39	70.9	68.1	18.2
	71	121.0	120.0	1.0

*Plasma potassium of undiluted blood. Each figure represents the mean of two aliquots. Control 225 c.c. of blood and 25 c.c. of 2.5 per cent sodium citrate.
Ammoniated blood 250 c.c. of blood 25 c.c. of 2.5 per cent sodium citrate.

1.3 milligrams per 100 milliliters. We concluded, therefore, that the apparent high potassium values were not due to ammonia but were genuine. This concentration of ammonia, however, is far in excess of that which Jacques and Osterhout have shown causes potassium to leave valonia.

To ascertain whether the addition of ammonia causes a similar diffusion of potassium

STUDIES IN BLOOD PRESERVATION

The Serum Potassium of Cadaver Blood

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AN observed increase in plasma potassium of a patient dying from an automobile accident (9) suggested a further investigation of this base in cadaver blood, especially as this source has been used extensively for transfusions (12).

The concentration of potassium within the intact red blood cells is twenty times that of the plasma. In this respect, the erythrocyte resembles the marine alga, *Valonia macrophylla*. In the latter Osterhout (5) explains the higher internal concentration of potassium as due not to the formation of insoluble compounds, but due chiefly to diffusion constants and concentration gradients the latter depending on partition coefficients (7, 8).

Osterhout's (6) quantitative studies on cell sap of *Valonia* have revealed a loss of potassium to be associated with injury. An other factor which causes these cells to lose potassium is an increase in ammonia. Jacques and Osterhout have shown that if the concentration of ammonia in sea water were raised by 0.001 molar there occurs a rapid exit of potassium from these cells.

Methods Under sterile precautions the blood was collected from the heart on a number of unselected cases, one portion was cultured and the remainder was introduced into a Sanfort Magath hematocrit tube and centrifuged for one hour. The average time of separation of serum from the cells was 35 hours after death. Potassium was determined by the argentocobaltinitrite method (10, 11) the final color being read on an Evelyn photoelectric colorimeter (3).

Results The average concentration of the serum potassium in these 17 cases was 101 milligrams per cent. These results contrast

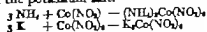
with our average of 17.2 milligrams per cent in the plasma of normal venous blood and the average of 29.7 milligrams per cent in the plasma of cardiac blood taken at death (9) (Table II).

HIGH SERUM VALUES IN CADAVER BLOOD

This high serum potassium approximately 3.5 times the concentration of that found at death and nearly 6 times greater than normal illustrates the rapid diffusion of potassium in cadaver blood. It takes refrigerated fresh blood 110 hours to reach approximately this same concentration. Factors affecting this rapid diffusion are many. Among them temperature is one for preserved blood is usually placed in the icebox immediately whereas many hours may elapse between death and storage of the cadaver. A second factor may be the ammonia concentration.

There has been much difficulty in determining the free ammonia in circulating blood. Folin and Dennis were the first to find values under 0.10 milligram ammonia N per 100 milliliters. Subsequently a value of 30 gamma (0.03 mg) per 100 milliliters was considered to represent the free ammonia N in circulating human blood. Conway with his isothermal distillation method has established the true value to be less than one tenth this amount or less than one part in thirty million."

Our interest in ammonia resulted from our curiosity about the high serum potassium values in cadaver blood. With the cobaltinitrite method it has long been known that if ammonia is present, there is a quantitative precipitation of ammonium cobaltinitrite along with the potassium salt.



Subsequent analysis for ammonia on several cadaver bloods gave the highest value to be

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HEMATOMAS OF THE UMBILICAL CORD

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HEMATOMA of the umbilical cord, excluding its origin from rupture of a large varix or aneurism of the umbilical vein, is an exceedingly rare complication of pregnancy and labor. In 1925, Schmidt (Halban and Seitz) was able to collect only 11 such cases of true hematoma of the funis.

We are not concerned with rupture of large varices or aneurisms, as reported by Adair and McDonald, and by Dworzak, since when these burst, the amniotic sheath ruptures also, as a rule, and there is rarely appreciable hemorrhage into the whartonian jelly. The deleterious influence of this condition on the antenatal life of the fetus is directly due to acute blood loss. We are including in this study only those hematomas which, though they may occasionally arise from rupture of small varices, appear to represent a different entity in that the integrity of the amniotic sheath is preserved,—at least until considerable blood has become effused into Wharton's jelly. The fetal mortality in these instances is due to partial or complete compression of one or more of the umbilical vessels.

Two instances of true hematoma of the umbilical cord were recently observed on the obstetrical service of the Johns Hopkins Hospital and this prompted a review of the literature on the subject as well as a study of all such cases seen on the service since its inception in 1896. The files of our obstetrical laboratory contain microscopic slides on 8 cases, in addition, 28 examples of true hematoma of the cord have been collected from the literature, giving a total of 36 cases for consideration.

Since we have encountered 8 instances of hematoma of the funis in 44,043 deliveries on the service, we observe an incidence of 1 case in 5,505 term or premature deliveries. Michailoff reported rupture of the umbilical cord as occurring 25 times in 26,442 deliveries and Forssell twice in 14,442, these figures include,

however, not only spontaneous ruptures resulting from pathological changes within the cord itself, but also ruptures from extraneous causes such as precipitate labors and instrumental deliveries.

A review of the 36 cases from the viewpoint of age and parity showed no relationship, the age of the patients ranging from 16 to 41 and their parity from 1 to 8. In 16 cases of the combined series the blood Wassermann reaction was known. This was negative in 14 instances and positive in only 2. This would seem of particular interest because syphilis of the umbilical cord is considered by Westphalen (33), Meyer, Marang, Schereschewsky, and Neuweiler, as a cause of hemorrhage into the umbilical cord. It should be recalled that round cell infiltration of the cord, upon which the mentioned authors establish their diagnosis of syphilis, does not conclusively prove the presence of syphilis, for Siddall encountered inflammation of the umbilical cord in 6 per cent of 984 cases in which clinical and serological syphilis had been definitely ruled out.

The duration of pregnancy was not given in 1 case collected from the literature, in the 35 remaining cases of the combined series, 2 deliveries took place in the eighth month of pregnancy, 30 approximately at full term, and 3 were definitely postmature. The birth weight of 17 infants of the combined series is known. Two infants weighed between 2,500 and 3,000 grams, 7 weighed 3,000 to 3,500 grams, 5 weighed 3,500 to 4,000 grams, and 3 were excessive in size, one of these weighing 4,500 grams. The sex of the fetus was stated in 18 instances, there were 8 males and 10 females, a sex ratio of only 80 as against the usually quoted birth sex ratio of 106.

In the combined series of 36 cases, the fetus was born alive in 19 instances, an immediate fetal mortality of 47 per cent. Moreover, there were 2 neonatal deaths, one fetus (32) being so badly asphyxiated that it was not resuscitated until after 1½ hours of artificial

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from red cells sufficient ammonium chloride was added to one of two similar portions of citrated blood to bring its concentration to approximately 0.01 molar. These specimens were stored in identically shaped bottles in a water bath kept at 38 degrees centigrade throughout the experiment (Table III).

The results indicate that with the addition of ammonium chloride a prompt rise in the plasma potassium takes place and the rate of diffusion of potassium is more rapid in the ammonia flask than in the control during the first seventy-one hours of the experiment.

SUMMARY

The increase in serum potassium is more rapid in cadaver than in fresh blood stored in a refrigerator at 4 degrees centigrade.

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Fig. Case. Photograph of the macerated fetus and part of the umbilical cord, showing the location and relative size of the hematoma.

respiration and eventually succumbed in a state of extreme pallor 28 hours after delivery. The other neonatal death (38) occurred on the third day and autopsy revealed pterus which had not been diagnosed previously. Of the stillborn fetuses, 7 had succumbed before the onset of labor and were macerated. One fetus died *in utero* 7 to 11 days before delivery. Ten fetuses succumbed during the first or second stage of labor and were not macerated. In 3 instances of prolonged labor due to uterine inertia, stillborn but non-macerated fetuses were delivered and the prolonged labor might have been the factor causing fetal death *in utero*.

Abnormal presentations and unfavorable positions of the fetus seem to play no rôle in the production of hematomas of the umbilical cord.

Absolute or relative shortening of the umbilical cord has frequently been mentioned as a factor in the development of a hematoma of the cord. Of the 8 cases delivered in our clinic, the average length of the cord was 63.25 centimeters, as against 66.31 centimeters for those 13 from the literature in which the cord length was given. There were no cords measuring less than 25 centimeters in length and only 5 in the combined series which were more than 75 centimeters long. The shortest cord measured 30 centimeters in length and

the longest 97 centimeters. Williams (37) gives the average cord length at about 55 centimeters. No true knots of the cord were encountered and loops about the fetus occurred only 8 times in the 36 cases. The cord was looped once about the fetal neck in 3 instances, twice about the neck in 2 and thrice about the neck in 1 and in 2 it was looped about both fetal neck and body.

The hematoma usually arises from rupture of the wall of the umbilical vein. The vessel involved was not mentioned in 4 cases of the combined series. In the 32 remaining cases the wall of the umbilical vein had ruptured in 28 instances, and an artery in 3. Meyer found no injury to the three large umbilical vessels in his case and believed the hematoma arose from a capillary of the umbilicus. From the researches of Bondi, Ruge and Stutz, it was learned that in every umbilicus there were nests of capillaries directly on the navel portion of the cord. These were shown by Hyrtl not to end in a sharp circulatory line at the level of the beginning of the amnion, but occasionally extended for a short distance into the cord. Ruge also found not infrequently remains of the vitelline vessels.

The hematoma is usually located near the umbilicus. In the combined series, the location is not mentioned in 7 cases. In 14 instances it was located directly on the umbilicus or extended to within 1 centimeter of the umbilicus. In 3 it originated 1 to 5 centimeters from the umbilicus. In 5, 6 to 15 centimeters from the umbilicus and in 6 it was located near the middle of the cord. In only 1 case was it near the placental end of the cord, and in this it originated 5 centimeters from the placenta. Hematomas are usually single anomalies but Delunsch, R. von Westphalen (34) and Diener each report an umbilical cord with two hematomas separated from each other by normal cord measuring 2 to 8 centimeters. In von Westphalen a case (34) the first hematoma from the umbilical vein was noted immediately after delivery of the living child. The cord was immediately clamped and two small varices were noted in the short piece of cord between the clamp and the umbilicus. A second hematoma developed under the eyes of the observer in the

remaining portion of the cord, increased rapidly in size, and soon ruptured through the amniotic sheath. There was barely space to tie the cord again just distal to the navel. In Delunsch's case, both hematomas arose from varicosities of the umbilical vein, were 8 centimeters apart, located near the middle of the cord, and a stillborn child was delivered. This cord was thin, almost devoid of Wharton's jelly, and the umbilical vessels were straight. In Diener's case both hematomas arising from varices of the vein were present at delivery of the living child.

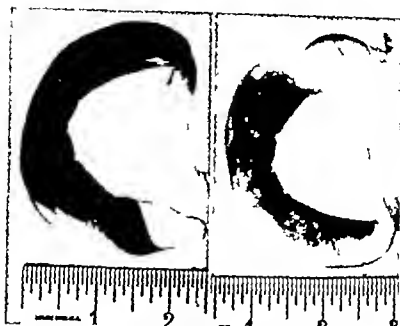
The hematomas vary greatly in size, the greatest diameter ranging from 13 centimeters to the size of a child's arm. They vary in length from 45 to 420 centimeters. They are usually fusiform or eccentric in shape but have been described as appearing in shape and size as a small sausage, a pigeon's egg, a hen's egg, a goose egg, and the arm of a newborn child. The general appearance is that of any collection of blood in tissues, i.e., bluish or reddish, but Kroemer and Freisfeld describe theirs as resembling a gangrenous gut.

The cause of rupture of the umbilical vessel cannot always be ascertained. In each of the cases of rupture of an umbilical artery, some anomaly of the vessel wall was noted microscopically. In one it was congenital thinning of the walls (Beckmann and Zimmer), in another, degenerative changes in the wall of one artery at the site of a loop (Westphalen, 35), and in the third, mucoid and fatty degeneration of the muscular walls (Schereschewsky). When the vein wall ruptures, the cause is less frequently determined. In 5 cases, rupture was thought to have arisen from a small varix, in 1 from a rather small but thrombosed varix, and in another from decreased resistance of the vein wall due to icterus (Woltersdorff). Couvelaire believed that in his case mechanical trauma to the cord in labor from tightening of a loop of cord around the fetal neck was responsible for partial blockage and increase in venous pressure, the vein wall having ruptured and not being recognizable microscopically for a distance of 4 millimeters. The rupture of the vein wall was ascribed to increased venous pressure due to obstruction of the venous flow by loops of cord about the fetus in 7 instances,



Fig 2 Case 1 Photomicrograph of high power magnification of the umbilical vein at the site of greatest deficiency of the vein wall. In all probability this represents the site of rupture of the vein.

to torsion of the cord in 3, and to rupture of the membranes in 1. As a rule, when no definite cause for rupture of the vein wall is apparent, it is ascribed to unequal intra-uterine pressure following rupture of the membranes, i.e., the withdrawal of the counterforce exerted by the amniotic fluid on the umbilical cord. It is believed that when the uterus contracts then and increases umbilical venous and arterial tension, a weak vessel wall will tear. This explanation, however, does not suffice to explain all cases since in one of our patients the hematoma was met at elective cesarean section, the membranes being intact. Galli was able to demonstrate actual trauma to the cord, since at the time of delivery the cord was found prolapsed just in front of the fetal head. He argues that since trauma and obstruction were imposed upon the cord and its vessels in the birth canal, the vascular pressure was increased with uterine contractions and the vein ruptured at the site of trauma. Stocker does not believe that the hematoma acquires enough pressure to



Figs. 3 and 4. Case 2. Transverse views of the hematoma showing that the hemorrhage did not completely encircle the cord. The circumference of the cord was not materially increased by the presence of the hematoma.

stop the flow of blood in the fetal vessels but that after rupture of the wall of the vessel, the blood coagulates at the site of rupture and a thrombosis develops within the lumen of the vessel as it does in aneurisms. On the other hand the dissecting ability of these hematomas would indicate that they do exert considerable pressure. Freisfeld believes that in his case the hematoma was formed, not by actual rupture of the vein wall but by diapedesis; he postulates that looping of the umbilical cord about the fetal body had caused obstruction to free blood flow in the umbilical vessels with resultant passive congestion and diapedesis.

There is, then, no adequate explanation for the occurrence of these hematomas. Mechanical forces probably play an important rôle. To find a single interpretation is difficult since the lesions of the umbilical vessels are so varied. The majority of the ruptures which occur near the navel may be due to traction on a short cord (actual or relative) during descent or delivery of the child as well as movements of a fetus with loops of cord

about its body or extremities. For those near the middle of the cord it may be due to trauma from the fetal head or shoulders to a low lying, though not actually prolapsed, loop of cord which becomes traumatized between fetal and maternal tissues. It may even be compressed here in the form of a kink and the vascular flow obstructed. Superimposed upon this is the forcing of placental blood during uterine contractions, into the umbilical vein to increase its tension.

Experimentally Freisfeld tried to produce an umbilical cord hematoma by forcefully injecting blood into umbilical veins of cord from newly born infants. The amniotic sheath invariably tore at the same time as the vein wall so rupture of the vein wall does not arise solely from increased intravenous pressure.

The diagnosis of hematoma of the cord can not be made before delivery. It can only be suspected from such evidences of fetal distress as irregularities in fetal heart tones, discharge of meconium stained amniotic fluid especially with descent of the fetus and bloody amniotic fluid.



Fig 5 Case 2 Photomicrograph of low power magnification of a cross section of the cord, at the site of the hemorrhagic area. The contracted umbilical arteries are pushed off to one side of the umbilical cord and are not completely surrounded by blood elements, while the hemorrhage is chiefly associated with the umbilical vein.



Fig 6 Case 2 Photomicrograph of high power magnification of the umbilical vein at the point of rupture. Note the defect in the vein wall, with blood clot which extends through this and is in communication with the lumen of the vein, as well as with the hemorrhagic area surrounding the vein.

The following case histories and illustrations are typical of this complication of pregnancy.

CASE 1 E J, No 152928, C W 5727. The patient was a 30 year old, white, secundipara, with a negative blood Wassermann whose estimated date of confinement was October 17, 1938. The pregnancy progressed normally until October 8 when fetal movements ceased, fetal heart tones had been heard on the previous day. Two days after fetal death *in utero*, labor was induced by premature rupture of the membranes and intramuscular pituitrin. After a labor of 4 hours, delivery was effected by low forceps. The fetus was a stillborn and macerated male weighing 4,315 grams (9.49 pounds). An autopsy revealed no fetal anomalies. As may be seen in Figure 1, the hematoma of the cord was situated directly on the umbilicus. The cord was only moderately enlarged by the hematoma and the hemorrhagic area measured 3.5 by 2 by 2 centimeters. The remainder of the umbilical cord was typical of one associated with a macerated fetus. The umbilicus was excised and it and the cord cut into several cross sectional blocks for microscopic study. On the placental side of the hematoma the umbilical vein was dilated with blood clot, measuring 1 centimeter

in diameter. The umbilical arteries here appeared grossly normal. On the fetal side of the hematoma, the vein and one artery were collapsed. Many intact umbilical capillaries were seen in this region. A cross section through the middle of the hematoma revealed that the vein was markedly dilated, the collapsed umbilical arteries were pushed over to the opposite edge of the cord, and the whartonian jelly was infiltrated with old blood. Microscopically, the vein wall was found to be thinned. The endothelial lining was ragged in several areas and at one point the muscularis was broken into but a complete rupture was not found. One of these defective areas is shown in Figure 2. There is no history of bodily injury or any fetal or maternal complication to explain the cause of this hematoma.

CASE 2 D M, No 143523, C W 5746. The patient was a 17 year old, colored secundipara, with a negative blood Wassermann, whose menstrual history was not reliable. The pregnancy progressed normally and she fell into labor spontaneously on October 29, 1938. The membranes ruptured spontaneously after 6 hours of labor and on admission 1 hour later, the cervix was found to be fully dilated. There was no evidence of fetal distress. She delivered spontaneously soon after admission, the fetal head emerging in left occipitoposterior position. The

child was a normal, living male, and weighed 3085 grams (6 79 pou ds).

The hematoma of the cord extended over a distance of 3 centimeters and to 3 centimeters from the navel. It did not completely encircle the cord as is shown in Figs. 3, 4, and 5, but proceeded along spiral course which followed the course of the umbilical vein. The cord in the region of the hematoma was only slightly larger than elsewhere. On cross section the hematoma was found to lie in the cord opposite the umbilical arteries and partially or completely encircling the vein. This was true only in the 3 centimeters of the hemorrhagic area nearest the navel. Distal to this region, and extending for a distance of 4 centimeters, the infiltrated blood encircled all of the umbilical vessels. Above this level, the hematoma decreased gradually in size, and at the upper margin of the discoloration of the cord, blood was found infiltrated only along the peripheral side of the vein.

Microscopically the umbilical arteries were moderately contracted, and their muscular walls were not remarkable. The vein on the other hand, was moderately dilated and its wall irregularly thinned. Near the midpoint of the hematoma area, the actual point of rupture of the umbilical vein is located. This is represented in Figure 6. Here the vein wall is contracted, and there is a defect involving approximately one-sixth the circumference of the wall. Blood elements are continuous with the hemorrhagic area and the lumen of the vein. In this region of the cord the hemorrhage almost completely obliterates the cellular outline of Wharton's Jelly. The cause of the rupture of this vessel is not known.

CONCLUSIONS

1. Hematoma of the umbilical cord is a rare complication of pregnancy and labor occurring about once in 5505 deliveries at or near term.

2. The great majority of hematomas occur at approximately full term.

3. Essentially one half of all fetuses whose umbilical cords contain hemorrhagic areas are stillborn.

4. The hemorrhage usually arises from rupture of the wall of the umbilical vein, though occasionally the wall of an umbilical artery ruptures and rarely does the hemorrhage arise from the capillaries of the fetal end of the funis.

5. The size of the hematomas varies greatly and the majority are located nearer the fetus than the placenta.

6. Maternal complications of pregnancy are neither common nor limited to syphilis and the toxemias.

7. The causes of rupture of an umbilical vessel are obscure and probably several factors enter into the development of a hematoma in each case.

8. Before delivery the only clinical evidence of the presence of a hematoma of the cord is that of fetal distress or occasionally that of vaginal bleeding.

We wish to thank Dr. J. M. Berglund for permission to include Case 1 in this report.

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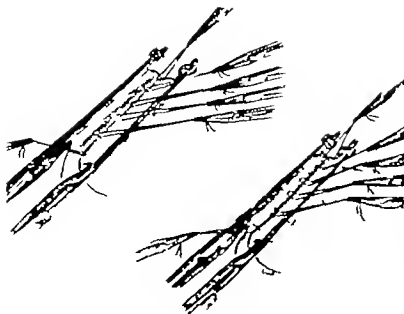


Fig. 5

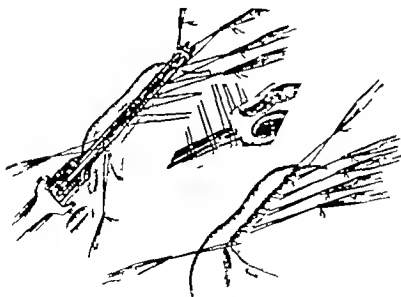


Fig. 6

Fig. 5 The posterior portion of the anastomosis is made first. The sketch on the left shows six anchor sutures in place. All sutures are of fine silk. In the first posterior row either the "plain-quilt" mattress suture or the interrupted Cushing stick is satisfactory. When all the anchor sutures are placed, they are tied and additional sutures are placed between. The second posterior row of sutures shown on the right should be of the Cushing type, for it permits placement of the sutures at the very edge of the crushed groove. Proper handling of the clamps is an important item in this case. The

lock sutures are placed. The responsibility of rotating the clamps properly is so important a function that the first assistant takes over this duty. While the second assistant aids the surgeon while the stitches are being placed. The ferrules are removed before the clamps are rotated for placement of the anterior row of sutures shown in Figure 6.

Fig. 6 The anterior row of sutures. The first row of stitches should be of the Cushing type. The inset shows the method of tightening the sutures and approximating the bowel edges as the clamps are removed. Additional sutures are placed between after removal of the clamps. The second row placed after the clamps are removed may be either the "plain-quilt" mattress suture or the Cushing stick. A special tightening device over the handles keeps the clamps securely apposed during placement of the first row of sutures before the clamps are removed. A double ferrule suffices to keep the ends of the narrow bladed clamps in position during placement of the first anterior row of sutures.

CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF MINNESOTA

ASEPTIC GASTRIC RESECTION

- I A Method of Aseptic Anastomosis Adaptable to Any Segment of the Alimentary Canal (Esophagus, Stomach, Small or Large Intestine),
- II Including Preliminary Description of Subtotal Excision of the Acid Secreting Area for Ulcer

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EVERY modern work on operative surgery devotes a section to description of the technique of performing aseptic intestinal anastomoses. The writings of Rankin have served to make adoption of the closed method of anastomosis a more commonly practiced procedure in partial excisions of the colon. Yet, even in this segment of the intestinal canal, the portion in which the closed method is most frequently used, more surgeons still make the open rather than the closed or aseptic anastomosis. Use of the Bloch-Mikulicz principle of exteriorization of colonic lesions, without question, contributes to continuance of the practice of making open anastomosis in the colon. The writer like most surgeons has given the closed methods (Parker-Kerr basting stitch and Rankin clamp) an occasional trial, but in the main he has continued to use largely the open method of intestinal anastomosis.

THE WRITER'S EXPERIENCE

Now for a period of somewhat more than a year, the writer has used the closed method exclusively in all anastomoses in the alimentary canal. This experience has been so satisfactory, as to suggest recording it. Primary anastomoses have been made by the aseptic method to be described between the lower esophagus and jejunum after total gastrectomy, between the stomach and jejunum after partial gastrectomy, between segments of small and large intestine as well as anas-

tomosis of the small intestine to the colon. End-to-end, end-to-side, and side-to-side anastomoses have all been made. In several instances as many as 3 separate anastomoses have been made at the same operation. Acquaintance with the applicability of aseptic anastomoses occasions the surgeon less hesitancy in making an extra anastomosis if it appears to be the procedure of election. In all these procedures, there has been but one death owing directly to a technical fault in the operative procedures. This patient had a gastrojejunal fistula. A one stage excision, resecting a large portion of the stomach including end-to-side anastomosis of the small intestine and end-to-end in the colon was made. This patient, Mr. E.S., U.H. No. 629454, aged 30, died 15 days after performance of the operative procedure and a small gastric fistula was found. On completion of the operative procedure, a hematoma was felt within the stomach. After it was evacuated with a large gastric tube, a running stitch of fine catgut was placed about the anastomosis. This extra suture rather hastily placed apparently devitalized a small portion of the gastric wall in the suture line. On a patient of 69 upon whom total gastrectomy was done for carcinoma of the entire stomach, an aseptic esophagojejunostomy was made. The patient died suddenly during convalescence, of coronary infarction. The anastomosis was intact and supported an intraluminal pressure of more than 100 centimeters of water, without the slightest trace of leakage (Mr. W.S., U.H. No. 683312).

THE WRITER'S METHOD

No new principle of anastomosis has been evolved in the writer's method of making an

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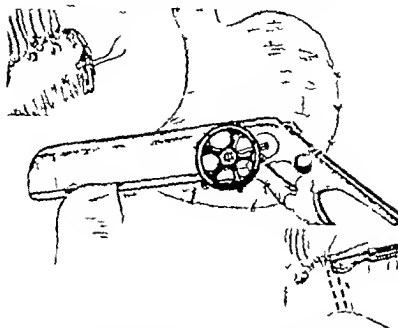


Fig. 1. Anastomosis of duodenum in Billroth II type of operation, employing the Pets clamp and suture apparatus. A single row of interrupted "plain-gut" Halsted mattress sutures of fine silk suture usually to make anastomosis in end.

aseptic anastomosis. As a matter of fact, in all methods union of the two intestinal segments is obtained by the placement of sutures upon the external surface of the bowel wall, the surfaces to be united being maintained in apposition through the agency of clamps, crushing or temporary sutures. The penetration of the intestinal suture whether interrupted or continuous, into the submucous layer of the bowel wall is, as was pointed out by Halsted in the open anastomosis, equally as important for the success of the aseptic closed anastomosis. The development of the aseptic mode of intestinal anastomosis including its many variants has been described recently so well by Spivack in 1937 that no allusion will be made here to the literature of the subject. The methods of Stone (20-26) and Wolfson published since Spivack's monograph are unique. However the ease of management of an instrument made up after the hemostat principle with a self-locking handle is so striking as to suggest that it is to be preferred to an assembled type of clamp needing more hands for its manipulation. Campbell and Dennis of this clinic have each described previously their experiences with the employment of aseptic anastomosis in intestinal resections.

It is adoption of the aseptic manner of anasto-

mosis to gastric resection that the writer is concerned with especially here—a procedure that has not been described previously as far as the writer has been able to learn. There will be those who will ask "Why make an aseptic anastomosis in the stomach." In reply the writer will only suggest that the lack of soiling and the refinements in the method of securing gastro-intestinal union, as contrasted with the open anastomosis, are so desirable as to suggest routine performance of the operation as the method of choice when gastric resection or gastropylorostomy are indicated.

THE TECHNIQUE

Over a period of several months, with the aid of Dr. Warner F. Bowers, surgical resident at the University Hospital, now of Omaha, the writer went frequently to the postmortem room and made closed anastomoses in all segments of the gastro-intestinal canal by well known methods (Parker Kerr & Rankin and Martaloff Burget, 18) noting carefully the subtle points in a satisfactory anastomosis. We soon convinced ourselves that a closed anastomosis made with interrupted sutures of fine silk carefully placed over forceps with a thin blade prevented the nearest end-result with least inversion of tissue—an anastomosis

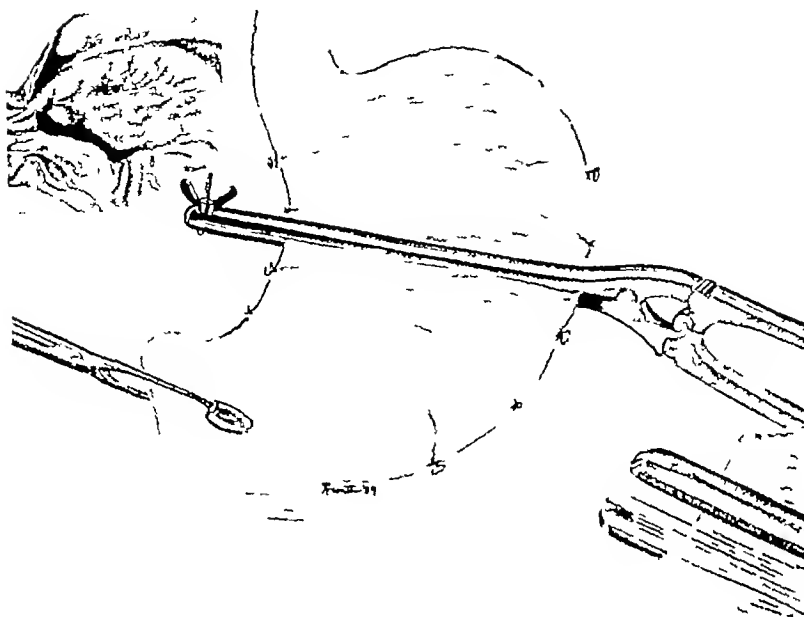


Fig 2 Placement of the large crushing forceps (made up after the Payr pattern) across the stomach at the site chosen for the anastomosis. The upper insert shows the crater of the carcinomatous ulcer. The lower insert, after removal of the tightening device, shows the groove in the gastric wall made by the crushing clamp.

when viewed from the interior appeared to be far superior to the open 2 or 3 row suture anastomosis. The Martzloff-Burget clamp of the available instruments for closed intestinal anastomosis appeared to meet the requirements of a satisfactory closed anastomosis most adequately. Using this clamp as a pattern, the writer asked the V Mueller Co in Chicago to make an intestinal clamp with a narrow blade of uniform width throughout, with a locking device to hold the clamps together during placement of the anterior row of sutures. A similar pair of long clamps was made for gastro intestinal anastomoses.¹

The use of these clamps in performing subtotal gastric resection of the stomach for malignancy is shown in Figures 5 and 6. It is apparent that the thickness of the gastric wall would cause the long thin blades of such a clamp to spread. In order to obviate this difficulty, a long crushing clamp of uniform breadth after the Payr pattern with a tightening device at the distal end was made up to crush the gastric wall, before placing the anastomosis clamp (Fig 2). In order to secure accurate coaptation of the longitudinal grooves of the instrument, a ferrule was made up to fit over the

tip of the clamp, as the blades were approximated (Fig 3). These ferrules are used also on the shorter intestinal anastomosis clamp. The technical steps involved in the Billroth II type of procedure performed for carcinoma or certain types of ulcer demanding this pattern of operation are shown in Figures 1 to 6.

Hemostasis In the colon and small intestine no special procedures are necessary in the normally vascularized gut to secure hemostasis incident to performance of closed anastomosis. In the stomach on the contrary, it is important to ligate the branches of the gastric vessels near the site selected for gastric section. The use of the large crushing instrument described and depicted in Figure 2, helps also to provide satisfactory hemostasis. The writer has not been content to rely upon these measures alone, however, and from the beginning, the coagulating current of a surgical diathermy apparatus has been applied to the anastomosis clamp at the site of gastric amputation to insure satisfactory hemostasis (Fig 3). A stop-watch is used uniformly and experience has shown that 6 to 10 seconds with the dial set at 70 (Bovee type of surgical diathermy apparatus) suffices to cause complete arrest of bleeding. Both nurses and house officers have expressed the

¹The instruments described herein may be obtained from the V Mueller Co Chicago.

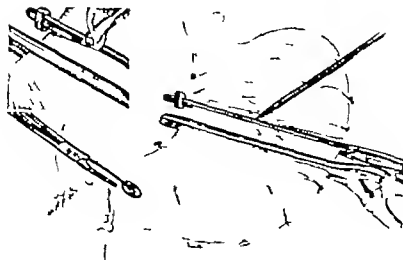


Fig. 3. The anastomosis clamp employed by the writer in gastric resections (patterned after the Martzloff intestinal clamp) is placed in the distal portion of the groove made by the crushing clamp. A ferret has been placed on the tip to insure perfect mesh of the longitudinal grooves of the blades. Preliminary crushing of the gastric wall as shown in Figure 1 makes it possible for this narrow bladed instrument to maintain the gastric wall closed securely. The coagulating current of surgical diathermy apparatus is applied for 6 to 10 seconds (stop watch) to augment hemostasis. Finally, as shown in the lower portion of the stomach, the stump is removed by amputating with the cautery. The anastomosis clamp is very thin blade the tissue should be divided not on, but

opinion repeatedly that the postoperative return of fluid through the inflying gastric tube to which suction is applied, is less bloody than in the open anastomosis. In only one instance has there been troublesome bleeding, viz. in the case of the gastrojejunocolic fistula referred to previously. The presence of a hematoma in the stomach was noted prior to closure and there was no postoperative bleeding. The type of gastric resection performed in this instance was as is indicated in Figures 14 and 15. The stomach was amputated by means of the Pets suturing apparatus and the area not employed in the anastomosis was merely inverted. Since this experience the area not employed in the anastomosis is oversewn regularly with a running stitch of fine catgut before inversion.

The technique of suture. In subtotal gastrectomy for malignancy the duodenum is divided as indicated in Figure 1. A single row of interrupted "plain-quilt" (Halsted) mattress sutures of fine silk over the Pets clips makes a satisfactory duodenal inversion.

Inasmuch as the residual gastric segment after resection can not be reversed because of the attachment of mesenteries at both curvatures, it is apparent that the posterior rows of sutures should

be placed before the anterior. A little practice has demonstrated this to be so simple that the anastomosis is made always in this manner even in the small bowel, where it would be easy to reverse the segment by a turn of the opposed clamps. Interrupted sutures of fine silk (Champion No. 1) are placed as indicated in Figures 5 and 6. Two rows are placed posteriorly and anteriorly. Posteriorly the deep row is placed first. The first row posteriorly and the second or final row of sutures anteriorly may be of the Halsted "plain-quilt" type or of the Cushing variety as shown in the illustrations. The Halsted interrupted suture as shown in Figure 14 affords maximal approximation and is eminently satisfactory. The Cushing type of suture permits placement of the sutures nearer the clamp than does the mattress suture of Halsted and is employed routinely for the second posterior and first anterior rows. In anastomoses in the small and large bowel whether end-to-end or side-to-side four sutures are placed usually before an are tied. Three sutures are then placed between these four. There are therefore seven sutures in each row posteriorly. When the mesentery in immediate juxtaposition to the bowel contains much fat, lateral anastomosis is more easily car-

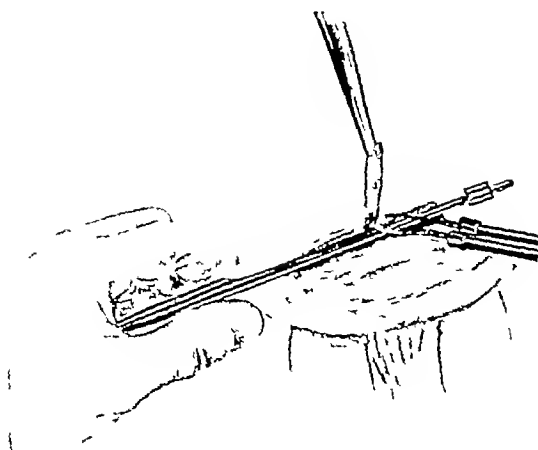


Fig 4. Removal of a slip of the jejunal wall preparatory to lateral anastomosis. The precaution observed in Figure 3 of cutting slightly above the clamp is followed here too. The ferrule is placed on the anastomosis clamp as its blades are being closed. A steel metric rule is employed to measure the exact length of the anastomosis in centimeters. This is an important item to secure absolute parity in length of the surfaces to be apposed by suture.

ried out than end-to-end and probably with greater safety. In the stomach because of the greater length, five or six sutures are placed usually before any are tied. Additional sutures are then placed between these. A hemostat is affixed to each suture, traction upon adjoining sutures makes placement of additional sutures between, a simple matter. Before the clamps are rotated for the placement of the anterior row of sutures, the single ferrules are removed. After the clamps have been properly apposed for the placement of the anterior row of sutures, the double ferrule engages the tips of the clamps and a tightening device over the handles holds the clamps securely. The anterior rows are placed as indicated in Figure 6. After the first row is placed the clamps are withdrawn. Gradual tightening of the sutures serves to avoid spillage. Upon completion of the second row of anterior sutures, care is taken to observe that the stoma is opened (Fig 7). In no instance has a suture catching both anterior and posterior walls of the anastomosis been felt.

Failure to approximate the mucosal edges does not appear to be a drawback. The Cushing stitch placed close to the clamps approximates the gastric and jejunal mucosa probably about as well as the continuous Connell suture, employed in the open anastomosis. Anastomoses made as a preliminary to this type of gastric resection on autopsy material suggested that the closed suture

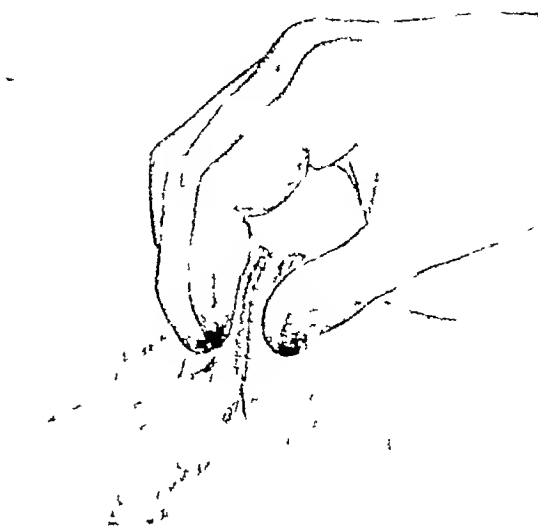


Fig 7. Opening the stoma with digital manipulation after completion of the anastomosis.

described here secured satisfactory approximation of the mucosa.

In gastric resection for malignancy, an entero-anastomosis is always made, no matter how tedious or difficult the procedure may have been (Fig 8). Avoidance of all potential complications is what makes operations upon aged poor risk patients suffering from malignancy possible with a uniformly low mortality rate. In a small series of consecutive gastric resections for malignancy

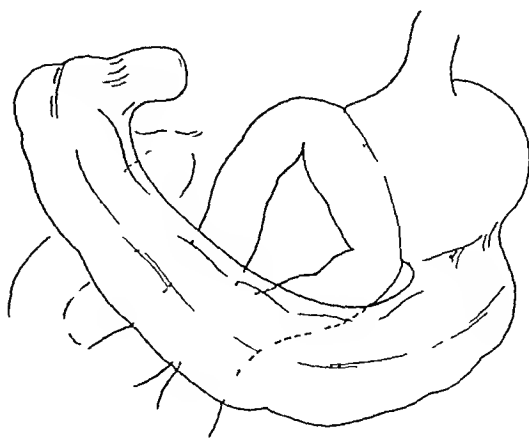


Fig 8. Schematic drawing of the completed operation. When this type of resection is made for malignancy, the writer invariably adds an entero-anastomosis. It only takes a few minutes to complete and is done in the same manner. Entero-anastomosis is omitted regularly in the Billroth II type of operation for ulcer.



Fig. 9. a, Small residual gastric pouch (estimated at 5 to 20 cubic centimeters on completion of the operation) in very high aseptic reaction done for carcinoma in situ of 7. b, also has pernicious anemia and has received treat-

ment for 3 years. There is some dilatation of the esophagus (31 N. M. J. M. No. 63765). b, The esophageal dilatation has disappeared and the gastric pouch has enlarged. c, The subcostal incision.

done over a 30 month period in which the open anastomosis was made reported previously (27) there was a mortality of 7.1 per cent. The posterior P-H type of anastomosis is employed quite regularly. When this type of reaction is done for benign ulcer however entero-enterostomy is omitted uniformly for otherwise the intragastric regurgitation feature will be largely lost—probably the most important principle of the operation, unless a large area of the corporeal zone of the stomach is excised also. Several subtotal gastric resections for malignancy have been performed by the aseptic technique described here in which very small residual gastric pouches remained after operation (see Fig. 9).

The incision. Experience has demonstrated that the incision which assures most ready access to the upper end of the stomach is a subcostal incision as indicated in Figure 10. The uppermost vessels in the gastrosplenic ligament can be divided usually without difficulty through this incision. Even with a long left rectus incision extending into the notch at the xiphoid, troublesome bleeding has been encountered occasionally in devascularizing the upper end if the greater curvature because of tearing of small veins in the gastrosplenic omentum incidental to traction upon the stomach. Access to the upper fundic portion of the stomach is relatively easy through this oblique subcostal incision and it also permits of satisfactory management of the duodenal stump. The incision is closed easily as is indicated in Figure 11. Interrupted silk sutures of the Halsted mattress type are employed to close the peritoneum and fascial layers. Postoperative hernia has not been observed in this type of incision and the patients can be gotten up by the seventh or eighth day

after operation—at least 3 or 4 days earlier than when the vertical incision is employed.

Pre-operative and postoperative treatment. In an earlier series of operations for gastric malignancy in which the open anastomosis was used previously reported, pre-operative gastric lavage with 120 cubic centimeters of tenth normal hydrochloric acid was employed (27). In the achlorhydric stomach this is undoubtedly a worthwhile step for the open anastomosis. The writer abandoned it, however, with adoption of the aseptic method.

An indwelling duodenal tube is passed into the stomach of each patient a few hours before he goes to the operating room. It remains there during the course of the operation being pulled back by the anesthetist into the upper rectum of the stomach or pushed back by the surgeon before the stomach is transected. Suction is in force during operation and is continued constantly for 72 to 96 hours without interruption after operation. The tube is then clamped for increasingly longer intervals and when its closure affords the patient no distress, the duodenal tube is withdrawn. Patients drink water as soon as they have awakened fully from the anesthesia and are well oriented.

Pyloric obstruction. In patients with high grade obstruction, the indwelling tube and suction may have to be used for some period of time prior to operation. As the volume of the return decreases, aspiration 2 or 3 times daily may be substituted for the indwelling tube. In this present series of patients, there were two with carcinoma of the stomach whose pyloric obstruction was especially severe. One of these had what appeared to be total occlusion after entry. After about 3 weeks of pre-operative preparation the gastric retention

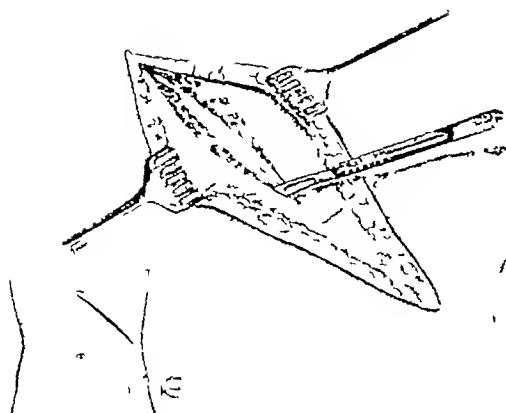


Fig 10 Incision employed to gain ready access to the fundic portion of the stomach

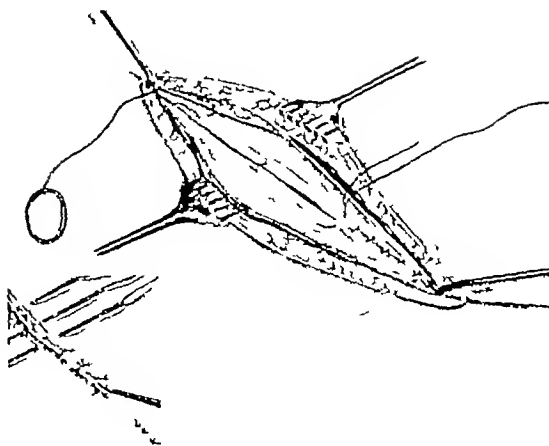


Fig 11 Closure of the incision

appeared still to be complete—the aspirations varying from 900 to 2400 cubic centimeters daily. This patient, Mr FS, UH No 679614, an obese man of 62, had ascites and considerable edema and a hypoproteinemia. A large number of transfusions of whole blood and serum (human) corrected this condition and made it possible to operate upon him without undue risk. The other patient, Mrs EW, UH No 679859, a thin woman of 50 years, had a similar situation, though not so severe.

In both patients an aseptic gastro-enterostomy was done. Each patient presented a localized operable lesion which in both instances, however, was large. Somewhat more than 4 weeks after the initial operation, both patients were reoperated upon, the intention being to excise the lesion. In each instance, a carcinoma of the peritoneum with gross fixation of the lesion was encountered, making removal impractical. This type of experience suggests that it may have been wiser to have done one stage gastric resections despite the antecedent stories of pre-operative obstruction. How much the trauma of the initial operations was responsible and how much the character of the lesions *per se* accounted for this rapid rate of growth can not be answered definitely. Whenever feasible, however, the one stage resection for malignancy should be performed. The writer's experience with palliative resections in the presence of irremovable nodes or even isolated hepatic metastases warrants continuance of this somewhat unorthodox procedure.

Anesthesia The writer has used inhalation anesthesia to the exclusion of all others. Age has been no contra-indication. In the colon group of

aseptic resections there was one patient of 79 and another aged 80, in the gastric series, the oldest patient was 78 years. Cyclopropane re-enforced by a small amount of ether occasionally, has been the anesthetic used regularly. A few minutes prior to the use of cautery the cyclopropane is discontinued and ether is given by the closed method.

Bronchoscopic aspiration Upon completion of the operative procedure the anesthetist aspirates the trachea with a urethral catheter through the larger diameter of the inlying intratracheal tube. If the patient's trachea is at all moist, bronchoscopic aspiration is performed regularly in the Trendelenburg position before the patient leaves the operating suite. This procedure (an excellent function for the anesthetist) together with employment of an intragastric inlying duodenal tube and a moderate Trendelenburg posture for a few days after operation constitute the best protection against the occurrence of atelectasis or pneumonia. Fowler's position has long been outmoded in this type of surgery and has, as a matter of fact, little place in abdominal surgery.

II A SUGGESTED PLAN OF OPERATION FOR ULCER USING THE ASEPTIC METHOD OF ANASTOMOSIS

In April 1935 the writer performed antral resection for a patient of 45 years Mr FF, UH No 627911, who continued to bleed occasionally from a duodenal ulcer more than 12 years after the performance of gastrojejunostomy. The duodenal ulcer was removed during the course of the antral resection and the stomach was resected proximally to the site of the stoma previously made. There was no roentgenological evidence of a gastrojejunal ulcer prior to antral resection and the stom-



Fig. 2. Excision of fundus. In provision for complete intragastric regurgitation of bile and pancreatic juice for gastrojejunal ulcer developing after antral resection.

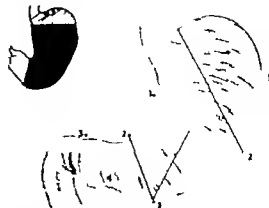


Fig. 3. A proposed type of gastric resection for ulcer. The greater curvature and the fundus are removed. The insert shows the functional activity of the stomach. In reference to the secretion of hydrochloric acid, in the antrum no acid is secreted. In the black zone, the distribution of the parietal cells in the gastric glands is maximal. Proportionally somewhat lesser numbers are to be found in the shaded zone (Berger).

was found quite normal at operation. Not long after performance of antral resection, however clinical and roentgenological evidence of a gastrojejunal ulcer appeared. Within the past year an identical experience was had with a young man of 24 years, Mr L.H. U.H. No. 669044. A gastrojejunostomy had been performed by the writer a short time before for an obstructing bleeding duodenal ulcer. Before the patient left the hospital, massive hemorrhages threatening emaculation occurred. Excision of the duodenal ulcer including the antrum was done despite the precarious condition of the patient. Erosion of the gastroduodenal artery with active bleeding into the bowel was observed at operation. The convalescence was surprisingly easy and the patient

left the hospital with gastric acid values which were high. The patient was informed that he might have further trouble. In less than a month, a gastrojejunal ulcer developed which could not be relieved by medical management.

In both these instances, the gastrojejunal loop was dealt with readily by dividing and inverting the jejunum beyond the stoma, the distal jejunum being anastomosed to the stomach. By this procedure regurgitation of the entire duodenal content into the stomach for purposes of neutralization is assured. In the instance of the last opera-

The emergency operations have now been done for massive hemorrhage in duodenal ulcer in patients who responded in shock unless blood was given continuously. An opening in the gastroduodenal artery was the common finding. Resection with excision of the ulcer and ligation of the bleeding vessel was done. Four recovered.

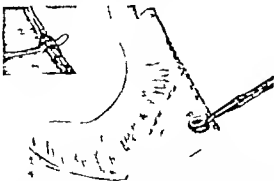


Fig. 4. Subtotal excision of acid secreting area for ulcer. A running suture of catgut is whipped over the Pets clips which are to be inserted. The insert shows the inversion afforded by the "plain-quilt" mattress suture of Halsted.



Fig. 5. The anastomosis after this type of gastric resection.

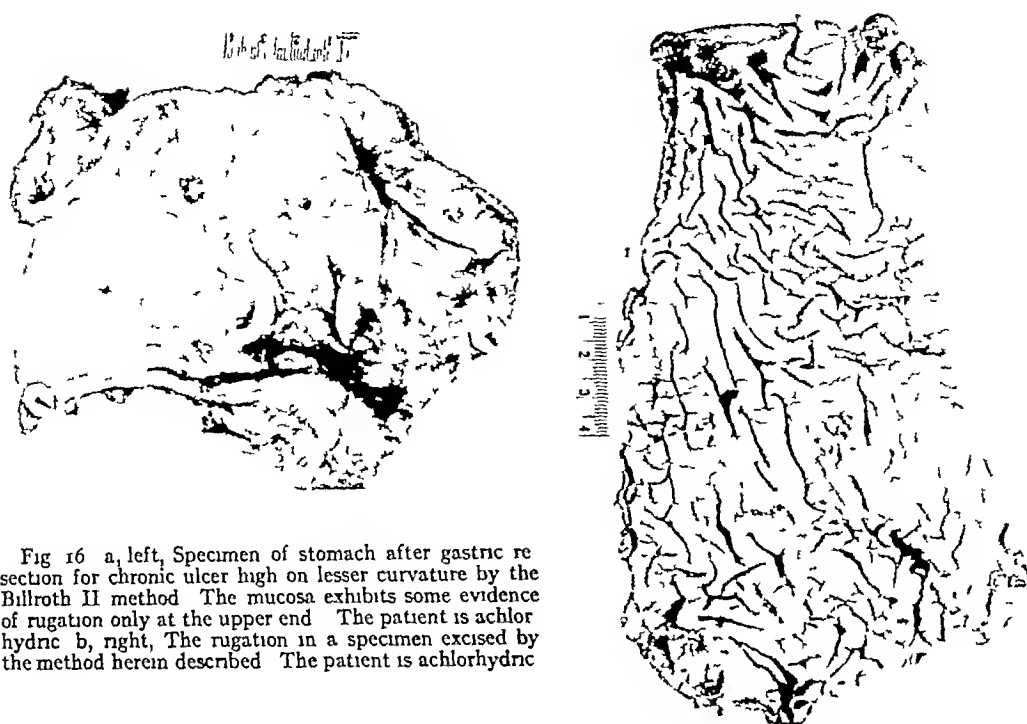


Fig 16 a, left, Specimen of stomach after gastric resection for chronic ulcer high on lesser curvature by the Billroth II method. The mucosa exhibits some evidence of rugation only at the upper end. The patient is achlorhydric. b, right, The rugation in a specimen excised by the method herein described. The patient is achlorhydric.

tion, performed on Mr. L. K., aged 24, referred to above, the fundus was excised also as indicated in Figure 12. In both instances roentgenological as well as clinical evidence of the gastrojejunal ulcer disappeared.¹ Since the performance of these operations, the writer has learned that Schmilnsky described this type of procedure to provide complete intragastric regurgitation of bile and pancreatic juice—a procedure which he referred to as an “internal apothecary” a number of years ago. The method apparently has never enjoyed any popularity. After the first operation, the writer performed several upon dogs, but unless the antrum was divided, mechanical difficulty with gastric emptying was encountered, giving rise to vomiting. Return of the entire duodenal content into the stomach, however, would appear to be a satisfactory operation for gastrojejunal ulcer occurring after the Billroth II type of operation (see Fig. 18).

Surgeons who have had recourse to radical methods of dealing with ulcer have adopted the principle of antral resection. This adaptation of the first gastric resections done for pyloric

malignancy to ulcer appears to have received ample justification in the observations of Edkins (8, 9). He, it is to be remembered, postulated following acute experiments upon the cat, employing gastric mucosal extracts from the cat and pig, that the gastric hormone for the secretion of hydrochloric acid had its origin in the mucosa of the antrum of the stomach. It had long before been shown by Heidenhain that only the corpus and fundus of the stomach secreted hydrochloric acid. The antrum, he observed, gave rise only to the secretion of an alkaline medium which was largely mucus. This observation of Heidenhain was confirmed amply by the histological studies of Bensley. Through the years the hypothesis of Edkins (8) concerning the source of gastrin has held the field, and surgeons in performing antral resection for ulcer have accepted this thesis. The antral mucosa, it is stated generally, controls and regulates the secretion of hydrochloric acid by supplying the stimulus which causes the parietal cells of the fundus and corpus to secrete. The common denominator of ulcer, it would appear from a number of studies (Mann, Dragstedt, Ivy, and others) is the acidity of the gastric juice. The objective of any well directed surgical therapy would, therefore, appear to be effective reduction of gastric acidity.

¹Mr. L. K. has died since of a perforation of another gastrojejunal ulcer in the new gastric outlet. The original gastrojejunal ulcer disappeared completely.

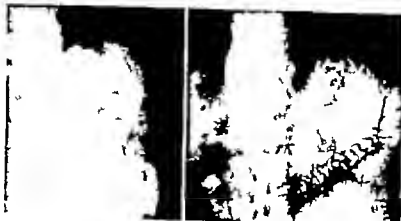


Fig. 7. X-ray films showing residual gastric pouches in two patients after subtotal excision of the acid-secreting area. Emptying occurs through the pylorus and new stoma in both. Both patients are achlorhydric even after instillation.

It has been noted not uncommonly that patients continue to secrete free hydrochloric acid from the remaining gastric pouch after antral resection including the pyloric sphincter done after the Billroth II type of operation. This occurrence has led surgeons to add increasingly greater amounts of the intermediate and corporeal zones of the stomach to the excised areas when performing gastric resection for ulcer (5, 6). On the basis that the greater amount of hydrochloric acid was secreted by the parietal cells in the fundic zone, Connell (5, 6) suggested and practiced excisions of a portion of the fundus of the stomach—an operation which he described as fundusctomy. This procedure to date does not appear to have been widely practiced and Seely and Zollinger (24) and Watson contend that such excisions in dogs are not followed by qualitative reduction in degree of acidity of the gastric juice. Whether a quantitative diminution in the total amount of acid secreted followed this type of procedure could be determined accurately only in isolated gastric pouches.

It would appear from available evidence that surgical procedures performed upon the stomach for the relief of ulcer concern essentially (1) Neutralization of the acid gastric juice by providing avenues for the regurgitation of the alkaline secretions of bile, pancreatic juice, and succus entericus into the stomach and (2) reduction of the capacity of the stomach to secrete hydrochloric acid. Surgeons have believed generally that the antral type of resection accomplishes this and the hypothesis of Edkins (8) lends tenable support to this thesis. That such operations accomplish this actually apart from whatever

neutralization occurs through the agency of partial intragastric regurgitation attending the establishment of the new stoma, is demanding of proof. The observations detailed here relating to the development of gastrojejunal ulcer immediately after antral resection suggests that Edkins' thesis may be invalid. Antral resection performed after gastrojejunostomy eliminates the normal avenue for intragastric regurgitation through the pylorus. It is admitted quite generally that pyloric exclusion done simultaneously with gastrojejunostomy intensifies the formation of gastrojejunal ulcer.

These facts suggest that the pain accruing from antral resection for ulcer is explicable largely on the basis of intragastric regurgitation through a new wide stoma. This suggestion must also, however, be submitted to direct experimental proof before being accepted as fact. At any rate, there appears now to be little factual support for the belief that antral resection *per se* reduces the secretory capacity of the stomach. The writer is now engaged with several associates in trying to secure direct experimental evidence upon this issue.

It would seem not unlikely, however, that each segment of the stomach functions in accord with its known cellular activity. Physiologists (3) and anatomists (2, 3) are in accord with reference to the particular cells (parietal) and their location which are responsible for the secretion of hydrochloric acid (Fig. 13).

THE WRITER'S METHOD

With these considerations as a basis, the writer has performed an operation in a few selected instances of complicated ulcer in which an attempt has been made to excise a large segment from that

portion of the stomach in which the secretion of hydrochloric acid is known to have its origin (Figs 14 and 15). This operation may be done readily through the incision shown in Figure 10. The weakness of the procedure lies in this, that the so-called "ulcer bearing area" remains behind and the ulcer or ulcers are not removed. The writer is inclined to believe that there are causes other than "tissue susceptibility" that bear upon the site of occurrence of ulcer. (See footnote below and legend for Fig 18.) Effectual reduction of the capacity of the residual portion of the stomach to secrete hydrochloric acid under any circumstances would appear to be the desired objective. This operative procedure is easy of performance, particularly because the continuity of the lesser curvature is not disturbed.

In the presence of a very short gastrosplenic omentum mobilization of the entire fundus may be somewhat difficult, ordinarily it is not. The only other item to which special attention should be drawn is that the anastomosis is made between two sutured areas of inversion (Fig 15). However, this matter presents no special difficulties. One could, of course, and the writer has placed the anastomosis at the lower inverted area, near the remaining antrum. Should for any reason, however, excision of the antrum be indicated subsequently, the presence of the anastomosis higher on the residual gastric wall would be a desirable feature. It is to be noted that only a narrow tube persists along the lesser curvature in the corpic zone after this procedure.

To date 7 patients have been operated upon by this method.¹ These were all complicated cases and included the instance of the gastrojejunal fistula referred to, another gastrojejunal ulcer, 2 instances of both gastric and duodenal ulcer and 2 instances of chronic duodenal ulcer of long standing exhibiting roentgenologically evidence of marked hypertrophic gastritis.

The fate of the gastrojejunal fistula has been described. Several postoperative gastric analyses on this patient showed free hydrochloric acid to be absent. Most of the patients have no free hydrochloric acid on a fasting stomach or after an alcohol test meal. Three patients have no free hydrochloric acid even after histamine on repeated tests performed several months after the operation. The only patient in the group who continues

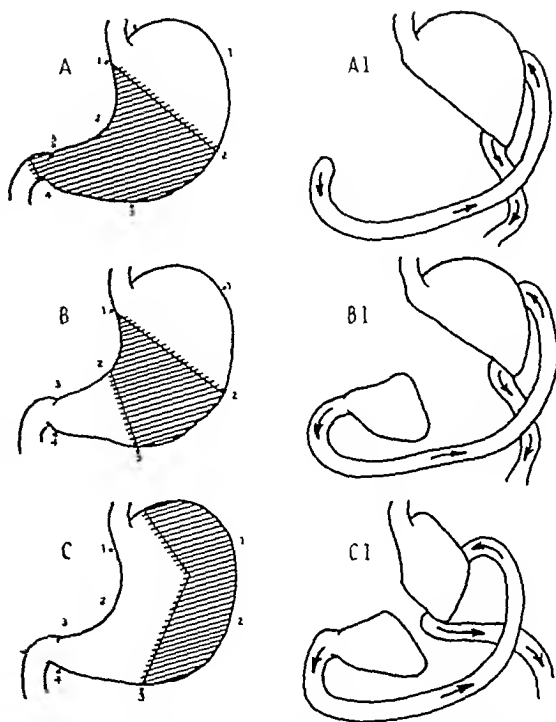


Fig 18 A, B, and C, Alternative effective means of reducing the ability of the stomach to secrete hydrochloric acid. In each instance the shaded portion is to be removed. It remains yet unsettled as to whether A is a more effective operation than B.

(A1, B1 and C1) Provision for complete intragastric regurgitation of the alkaline duodenal secretions will suffice to augment the effects of reduction of gastric secretory capacity. It is to be noted in C1 that severance of the upper and lower pouches is suggested when provision for complete regurgitation is made.

In young patients, who are more prone than the older group, to development of gastrojejunal ulcer, a studied effort to omit a gastrojejunal anastomosis should be made. The writer has the impression that "tissue susceptibility" with reference to the site of ulcer formation has to do in large measure with the constant bathing of tissue with acid at the gastric outlet. High anastomoses, therefore, unless the stomach is totally achlorhydric are probably undesirable. Heretofore, the emphasis has been on what is the proper segment of the small intestine with which to establish the anastomosis. The writer believes that the more important issue is what segment of the stomach should be employed in the anastomosis. The answer in part is, undoubtedly, that an efferent outlet high upon the stomach in the midst of the active acid secreting area is more likely to be followed by gastrojejunal ulcer than when the outlet is made beyond the confines of this area, unless the stomach is achlorhydric.

¹Since this paper was written 2 additional patients have been operated upon by this method. In 1 of these a young man of 31 years Mr F. W. U. H. No 664783 with intractable pain of 3 years duration, anastomosis was omitted altogether. The left vagus nerve was sectioned at the cardia. Despite the narrow gastric tube the stomach empties very rapidly and the patient is achlorhydric even to histamine. Omission of gastrojejunostomy in young persons to obviate gastrojejunal ulcer is highly desirable.

to have symptoms is the patient who still has free hydrochloric acid on a fasting stomach after excision of a gastrojejunal ulcer. In this patient excision of the upper fundus beyond the insertion of the esophagus was omitted.

The pattern of gastric mucosa in resected specimens removed by the Billroth II and the writer's method for ulcer are quite different as is apparent in the contrast afforded by Figures 16 a and b. The gastric rugae are most prominent in the corpore and fundic zones where the parietal cells which secrete hydrochloric acid are to be found.

This somewhat meager experience with subtotal excision of the acid secreting area accompanied by gastrojejunostomy for ulcer in a few selected cases suggests that this mode of gastric resection may have some merit. Whenever excision of the ulcer appears in order because of hemorrhage or because of the possibility of a gastric lesion being malignant, the Billroth II plan of operation with removal of the tissue in question is, of course, the operation of choice. In such procedures, however it is important to excise a good segment of the corpore zone for mere sacrifice of the antrum will not insure effective reduction in gastric acidity. Either plan of operation may be carried out readily by the aseptic technique. Antral specimens exhibit often no evidence of rugation.

The resultant type of gastric pouch, attending subtotal excision of the acid secreting area of the stomach, is shown in Figure 17. These pouches empty satisfactorily and vomiting has not been observed. Emptying occurs through both the antrum and the pylorus. Because the gastric pathway at the lesser curvature is narrowed considerably I have routinely performed gastrojejunostomy to facilitate emptying. Whether such stomach would function properly without this new stomach I do not know. Occasionally a patient complains that his gastric capacity is not as great as he would desire. The time factor of accommodation eventually adjusts this complaint quite adequately.

Extensive excision of the acid secreting area and provision for complete intragastric regurgitation should suffice to deal with the most intractable type of ulcer. Alternative methods of achieving this objective are illustrated in Figure 8. Intragastric regurgitation through the ordinary gastrojejunostomy (including the Billroth II type of procedure) is only partial.

Babkin has pointed out that the fibers of the vagus nerves exert greater influence on the (appetite juice) secretory capacity of the lesser curva-

ture than on the greater. Division of the fibers of the vagus nerves decussating over the gastric wall may readily be done in conjunction with the procedure described by the writer. If experience should suggest that it be done to augment the effect of subtotal excision of the acid secreting area.

SUMMARY

A method of performing aseptic gastric resection by the closed method is described—a technique adaptable to any portion of the alimentary canal where anastomosis is to be done after excision of a segment. Subtotal excision of the acid secreting area in the stomach accompanied by gastrojejunostomy is described as a suitable measure for effectual reduction in gastric acidity for ulcer.

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A METHOD OF VALVULAR CHOLECYSTGASTROSTOMY

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RECENT advances in the surgery of the pancreas have renewed interest in cholecystgastrostomy and cholecyst-enterostomy. But the wide diversity of opinion which exists both in regard to the method to be followed and the proper site for such anastomoses implies that none of the common procedures is entirely satisfactory. The stomach has been more widely used for this purpose because of its mobility and accessibility. Although moderately effective as a palliative procedure, cholecystgastrostomy has been found by Whipple to result in cholangitis and hepatitis when combined with gastro-enterostomy preliminary to resection of the head of the pancreas. As a result of such experiences other sites and types of anastomoses have been advocated in an effort to avoid ascending biliary infection.

Following a direct anastomosis of the gall bladder to the gastro-intestinal tract, the biliary system is no longer protected by the valve mechanism of the sphincter of Oddi. Consequently there is an interchange of contents between the gall bladder and the gastro-intestinal tract causing an infection, usually so mild that it does not produce clinical symptoms, or again one of a very serious nature. Bernhard has reported barium regurgitation into the biliary passages at the time of a gastro-intestinal series in as many as 50 per cent of such patients. This loss of the valve protection has been conspicuous in cholecystgastrostomy, because the strong peristaltic waves of the stomach often fill the gall bladder and bile ducts with gastric contents. This is highly undesirable if ascending biliary infection is to be avoided, and it is one of the reasons that Lahey and MacKinnon have advocated the use of the upper jejunum for anastomosis. Whipple has reported satisfactory results using the Monprofit type of direct cholecystjejunostomy by the Y method in an attempt to avoid, if possible, the direct interchange of contents between the gall bladder and the main jejunal stream. On the other hand, Brunschwig and others have used a long loop of jejunum for the cholecystenterostomy combined with an entero-enterostomy. Yet despite such extensive precautions, ascending biliary infection has developed. If, however, an effective

valve mechanism could be devised for cholecystgastrostomy, the major objection to this procedure would be overcome, and many of the more complicated methods of multiple anastomosis would be unnecessary.

Various attempts to produce a valve for cholecystgastrostomy have been made. Mason sought to develop muscular control between the gall bladder and stomach by separating the muscular wall of the stomach with a hemostat passed through an opening near the greater curvature. The gall bladder was then pulled into the lumen of the stomach through an opening near the lesser curvature and was anchored in this position by a row of silk stitches. Roeder excised the redundant portion of the distended gall bladder saving only the amount required to sew around a No. 16 catheter. A flap of Penrose tubing was fastened to the end of the catheter in an effort to counteract back pressure into the gall bladder. The newly made tubular structure was then buried for a short distance in a tunnel in the anterior gastric wall before it entered the lumen of the stomach. The catheter was passed out 3 to 9 weeks after operation. Mirizzi mobilized the gall bladder until a portion of the fundus could be drawn within the duodenum and anchored in position. Gentile attempted to perform a cholecystgastrostomy based on one of the principles advocated by Coffey for transplanting the ureter, which depends upon the formation of a stoma by the sloughing of a transfixing suture between the lumen of the gall bladder and the stomach. In order to follow this principle a portion of the gall bladder was imbedded within the stomach wall for a distance by anchoring the seromuscular coats over it. No opening developed, but Gentile made the interesting observation that the portion of the gall bladder within the wall of the stomach had shrunk until it resembled a tube.

In spite of Gentile's failure it seemed that the Coffey principle of oblique implantation to obtain a valve action could be applied in cholecystgastrostomy. Moreover, the dilation and elongation of the gall bladder which usually follow the obstruction of the common duct from malignant disease would facilitate this type of anastomosis. In addition, the blood supply coming upward from the region of the cystic duct would not be destroyed if the gall bladder were detached for a

From the Surgical Clinic, Peter Bent Brigham Hospital and the Department of Surgery, Harvard Medical School.

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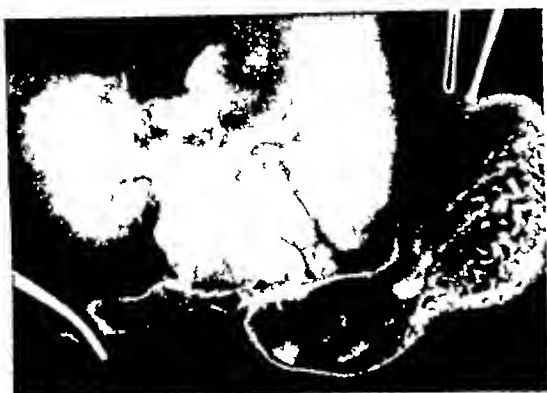


Fig 4 Cholecystgastrostomy, direct anastomosis, 167 days after operation. Note the tremendous dilation of the extrahepatic and intrahepatic bile ducts by sodium iodide injection. Air injected into the stomach has entered directly into the gall bladder.

trostomy. Ten animals were used and sacrificed from 55 to 213 days after operation, the average being 151 days. The results were not satisfactory in this group as a whole because of stenosis of the stoma in over one-half of the experiments. This was due to several factors, one being the failure to divide the common duct after double ligation with silk. In several instances the patency of the common duct was re-established, yet it is well known that the artificial stoma often closes if the common duct obstruction is relieved. Probably the most important cause of stenosis, however, was pulling the fundus of the gall bladder within the lumen of the stomach instead of anastomosing it with sutures directly to the opening in the mucous membrane (Fig 7). One animal showed mild hepatitis and one very old dog a diffuse hepatitis. The remainder gave little evidence of biliary infection other than an occasional leucocyte about the bile ducts. According to our one experiment in this group, valvular cholecystoduodenostomy, in the dog at least, was not technically a satisfactory procedure.

In the third group of experiments the final technique of valvular cholecystgastrostomy described in Figures 7 to 17 was carried out in 4 animals. The common bile duct was doubly ligated and divided in each experiment. A cross section of the completed procedure to show the location of the gall bladder in relation to the anterior gastric wall is shown in Figure 7. This procedure varied from that used for the previous group in that the fundus of the gall bladder was directly anastomosed to the gastric mucosa instead of being anchored within the lumen of the



Fig 5 Photograph of specimen of cholecystoduodenostomy, 315 days after operation. Note the accumulation of hair within the gall bladder.

stomach. The anterior gastric wall was grasped at the desired level. Then an enterostomy clamp was applied from the greater to the lesser curvature (Fig 8), which not only controlled the blood supply and prevented spilling of gastric contents but held the gastric wall for the subsequent steps of the operation. An incision, extending from the lesser to the greater curvature, was made through the serosal and muscular layers of the stomach down to the submucosa. To avoid constriction of the gall bladder and interference with its blood supply when buried in the gastric wall, a transverse incision about 3 centimeters long was made in the stomach wall near the lesser curvature (Fig 9). Invariably several bleeding points, especially those near the lesser curvature, required a ligature. The new gall-bladder bed was

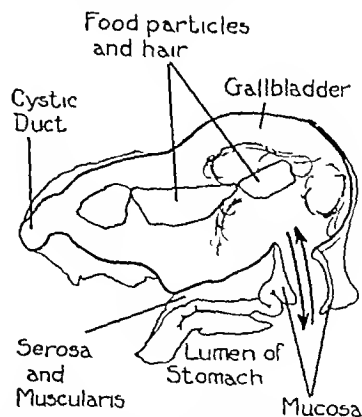


Fig 6 Drawing of direct cholecystgastrostomy showing hair and particles of food in the gall bladder. Note the absence of valvular mechanism permitting the free interchange of contents between the stomach and gall bladder.



Fig. 1. Injected specimen of direct cholecystostomy taken 67 days after operation. Note the regurgitation of barium from stomach directly at gall bladder and ducts.



Fig. 2. Cholecystoduodenostomy direct anastomosis, 35 days after operation. Note regurgitation of barium directly into the gall bladder.

few centimeters from its bed. To test the feasibility of such a technique as well as the effectiveness of a constructed valve in preventing regurgitation within the biliary tree a series of experiments was conducted on dogs.

EXPERIMENTS

Three groups of experiments were performed under intravenous nembutal anesthesia with sterile technique on average size dogs. Fine silk suture material was used throughout.

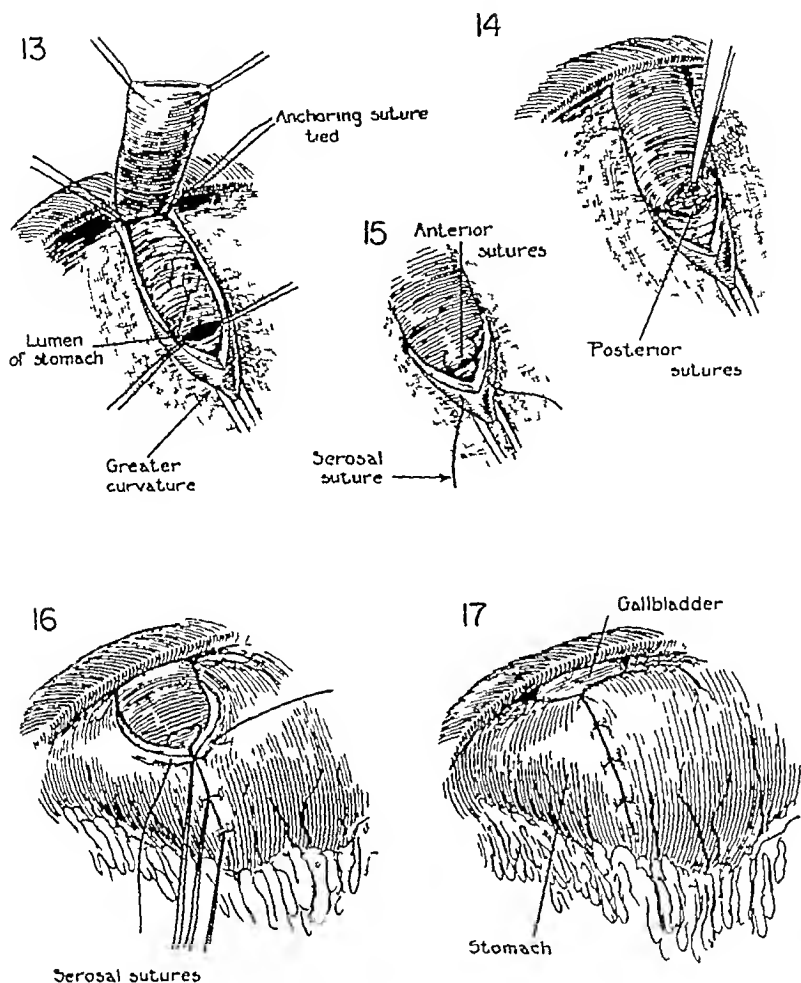
In the first or control group 4 direct anastomoses were made between the gall bladder and stomach or duodenum. A sufficient number of similar experiments have been reported to indicate clearly that intestinal contents have been



Fig. 3. Cholecystoduodenostomy direct anastomosis, 35 days after operation. Visualization of gall bladder and intrahepatic bile ducts with sodium iodide solution. Note the dilated intrahepatic bile ducts.

found in the gall bladder and that the incidence of hepatitis following this operation in dogs may range from a low to an extremely high percentage. In these 4 control dogs intensive index determinations taken at irregular intervals were never elevated. Moreover these animals were in good health when sacrificed from 3 to 315 days after the operation. Following sacrifice the liver, biliary passages, stomach and duodenum were immediately removed *en bloc*. The stomach was filled with barium but since the barium did not always pass the pylorus, it was necessary occasionally to introduce the barium directly into the duodenum. In 3 of the 4 specimens the barium regurgitated into the gall bladder and major ducts (Figs. 1 and 2). Studies of the gall bladder and biliary passages were then carried out by the injection of concentrated sodium iodide solution, which showed definite and usually marked dilation of not only the extrahepatic but the intrahepatic ducts (Figs. 3 and 4). When the stomach and duodenum were moderately inflated with air the air penetrated promptly into the biliary passages (Fig. 4). In 3 of these 4 animals hair or particles of food were found in the gall bladder clearly indicating that the intestinal contents had found their way into the biliary passages (Figs. 5 and 6). There was a minimal amount of microscopic evidence of biliary infection except in one experiment of cholecystoduodenostomy. This animal sacrificed after 35 days showed fatty metamorphosis of the liver both grossly and macroscopically with some evidence of leukocytic infiltration about the bile ducts.

The second group of experiments comprised the early attempts at alveolar cholecystogast-

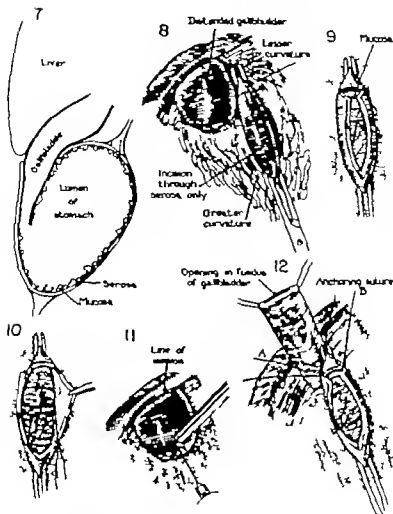


Figs 13 to 17 Technical steps in valvular cholecystgastrostomy

mucous membrane was completed either with a continuous suture or with a row of interrupted sutures. Interrupted silk sutures which included the seromuscular flaps on each side as well as a small bite of the gall bladder were subsequently taken (Figs 15 and 16) until the seromuscular layer was completely approximated, burying the gall bladder. The value of the transverse incision in the seromuscular layer near the lesser curvature was now apparent, because it prevented excessive constriction of the gall bladder as it entered the gastric wall (Fig 17). One row of sutures in the seromuscular layer was found to be sufficient.

Other than the one which died from distemper in 35 days, the dogs in this group were in good health when sacrificed in 272, 273, and 321 days,

respectively, after operation. Immediately after sacrifice the liver, biliary passages, stomach, and duodenum were removed intact. The stomach was filled with barium, but in none of the valvular cholecystgastrostomy experiments did barium regurgitate into the gall bladder (Fig 18). A cross section drawing made of the 35 day specimen illustrates how the valve protection was attained (Fig 19). Visualization of the gall bladder and biliary tree by the injection of concentrated sodium iodide solution (Fig 20) showed that the intrahepatic ducts were not dilated so much as in the non-valvular anastomoses. Cultures of the bile at the time of sacrifice showed *Bacillus coli* in all specimens and in addition a non-hemolytic streptococcus in one animal. There was no stenosis of the stoma, and in none of the specimens did



Figs 7 to 12 Technical steps in valvular cholecystogastrostomy

then prepared by the use of blunt or sharp dissection until liberal seromuscular flaps had been developed on either side of the incision (Fig. 9). Following this the gall bladder was prepared for the anastomosis.

The contents of the gall bladder were aspirated (Fig. 10). After traction sutures of silk had been placed on each side of the gall bladder an opening approximately 3 centimeters long was made in its fundus (Fig. 11). When the gall bladder was not sufficiently elongated to permit its implantation for at least 5 centimeters, it was detached for the desired distance from the liver bed by first incising the peritoneum around the fundus and down either side and then dissecting within

the cleavage plane between the gall bladder and liver bed. The final steps of the operation were facilitated if the lesser curvature was anchored early to the under side of the gall bladder (Fig. 12, A and B). Traction sutures of silk were placed in the submucosa near the greater curvature of the stomach and a small portion of gastric mucosa was excised between them (Fig. 13). It has been proved to our satisfaction that the fundus of the gall bladder should be anastomosed directly to the mucous membrane of the stomach (Fig. 14) since in experiments where the fundus projected into the lumen of the stomach for a distance stenosis of the stomach occasionally occurred. The anastomosis of the fundus to the

1

2

3

4

5



Fig 21 Photograph of specimens of valvular cholecystgastrostomy 272, 321, and 273, respectively, days after operation. Note the absence of hair or gastric contents in the gall bladder in contrast to Figures 5 and 6

were performed as palliative procedures. The icteric index dropped from 70 before operation to 22 by the thirteenth postoperative day. Following a gradual decline, she died on the seventy third postoperative day.

CASE 4 A 63 year old man was admitted complaining of jaundice of 6 weeks' duration. The icteric index was 147. At operation under novocain anesthesia a greatly distended gall bladder was found filled with clear, white bile. The head of the pancreas was of normal size, slightly nodular, and rather firm. Because of the poor general condition of the patient further exploration did not appear justifiable. A valvular cholecystgastrostomy was performed. The icteric index dropped from 147 before operation to 23 by the twenty second postoperative day. The patient cleared of his jaundice returned to work for a year as a gardener. He was readmitted to the hospital 15 months later with symptoms of pyloric obstruction. A gastro intestinal series showed a large gastric residue at 6 hours. The descending portion of the duodenum was irregular and narrowed by the tumor. There was no regurgitation within the gall bladder. The icteric index was 17. The stools had a normal, dark brown color. He was re-operated upon under novocain anesthesia, and extensive metastasis to the liver was found. A posterior gastrojejunostomy was done to relieve the duodenal obstruction. He died 82 days later or 18 months after the valvular cholecystgastrostomy. There was no evidence of cholangitis at any time. In spite of the duodenal obstruction there was no regurgitation of barium into the biliary passages.

CASE 5 A 69 year old, colored man was admitted to the hospital with jaundice of 5 months' duration. The icteric index was 64. There was an enlarged, tender liver and a non tender mass in the right flank. Under novocain anesthesia a valvular cholecystgastrostomy was performed burying the elongated, distended gall bladder about 3 centimeters in the anterior gastric wall. The immediate postoperative course was satisfactory.

These patients proved to our satisfaction that valvular cholecystgastrostomy is technically feasible in patients. In 4 instances the operation was performed under local anesthesia by different operators. There was no difficulty encountered from bleeding in any of the cases. Three of the operations were performed with the technique of pulling the fundus within the lumen of the stomach before the experimental evidence so clearly indicated the necessity of anastomosing the fundus of the gall bladder directly to the mucous membrane of the stomach. Although this technique of cholecystgastrostomy may not offer advantages in advanced cases of carcinoma, such as the first 3 cases reported, it warrants further clinical trial if there is a reasonable expectancy of prolonged survival or if there is to be a subsequent resection of the neoplasm.

CONCLUSIONS

A method of valvular cholecystgastrostomy has been devised which experimentally prevents gross regurgitation of gastric contents into the biliary tree.

The procedure has been carried out in 5 patients and has proved a simple undertaking which can be performed under local anesthesia in poor risk patients. Only further clinical trial will prove or disprove the effectiveness of valvular

cholecystogastrostomy in lowering the incidence of ascending biliary infection

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ENTEROGENOUS CYSTS

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ENTEROGENOUS cysts or enterocystomas are terms applied to congenital cysts arising from the gastro-intestinal tract. They may occur in any part of the tract from the esophagus to the sigmoid but are most commonly found in the ileocecal region. To the 30 in this area recorded in the literature 2 others are added in this report. The first case of this kind was reported by Fraenkel in 1882. In recent years an increasing number have been found and many may have been overlooked. Most of those reported have been in infants, but Thiers reported one in a man 26 years old. Strod and Fennel reported a case in which 2 adjacent cysts of somewhat different histological structure were present in an infant, producing an intestinal obstruction just above the ileocecal valve. Several of these cysts have been reported in the duodenum and McLanahan and Stone report 3 cases affecting the rectum.

These cysts are closely related embryologically to congenital diverticula. Their origin when occurring in the terminal ileum, is due to a remnant of the omphalomesenteric duct. While Meckel's diverticulum is the commonest form of anomaly due to improper closure of this duct, any remnant of this embryological structure may persist to form a cyst. Such a cyst may be present in the wall of the ileum in the abdominal cavity with a fibrous attachment to the ileum or umbilicus, or in the abdominal wall itself anterior to the peritoneum with no attachment whatsoever to the abdominal cavity. A fully developed cyst may

occupy any place in the intestinal wall. It may be intermuscular, submucosal, or subserosal. The latter may occur on the mesenteric or antimesenteric surface. Sometimes a subserosal cyst on the mesenteric border loses its attachment to the gut wall and occupies a position between the layers of the mesentery more or less removed from the parent gut.

The structure of the cyst wall resembles that of the intestinal wall consisting of mucosa, submucosa and muscularis. The epithelium lining the cyst is subject to great variations in structure and may be stratified columnar cylindrical, atrophic, etc. This is partly due to the intra-cystic pressure or inflammatory changes, but of greater significance is the embryological consideration.

Cases of reduplications of the intestinal tract have been reported in which a variable length of bowel, blind at both ends, has existed in close proximity to the main gut. Such a so called reduplication of the bowel probably originated from a long diverticulum and may be classified more accurately as enterocystoma, being tubular rather than globular.

In cysts of the duodenum the symptoms usually occur in infancy with vomiting the outstanding symptom and a resemblance to the picture of congenital pyloric obstruction.

The predominance of appendicitis in the pathology of the ileocecal region, with its many manifestations and complications, may unconsciously influence our judgment in evaluating the signs

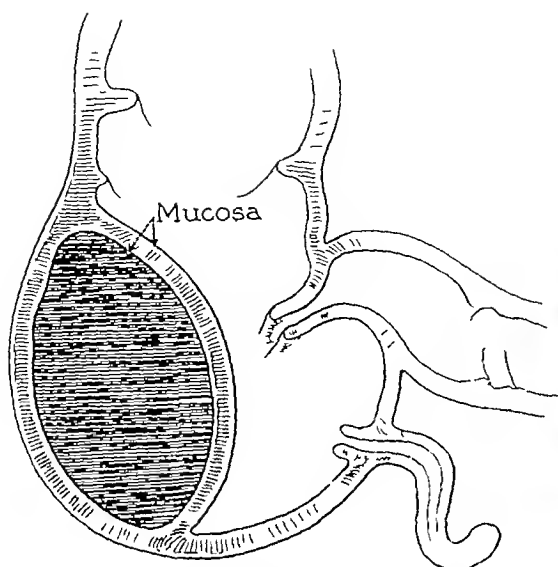


Fig 1. Diagram of Case 1 showing the position and relationship of the enterogenous cyst in the cecum before the cyst became acutely infected and distended

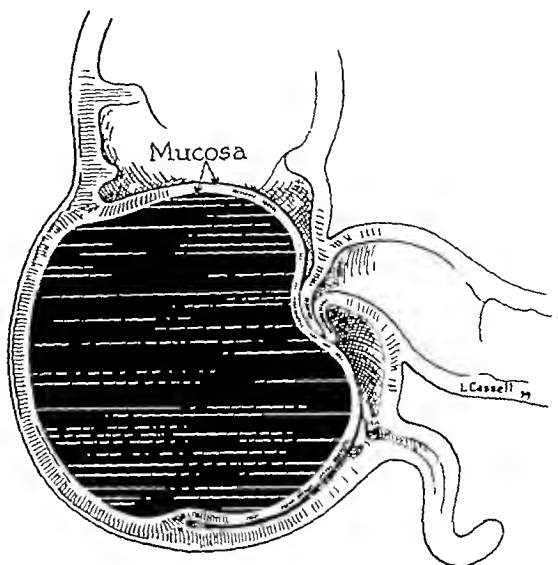


Fig 2. Diagram of Case 1 showing how the distended cyst obstructed the ileocecal valve

and symptoms of an enterogenous cyst in this region and make a correct diagnosis more unlikely. Obstruction, infection, or both are the factors producing the symptoms. Pressure, tension, or distortion, due to the presence of the cyst, may produce a variety of signs and symptoms. Interference with the circulation, the nerve supply, or the lumen of the bowel, may produce certain evidence. The clinical picture will vary with the part affected and the degree of interference with normal function. If only small embarrassment results, the cysts may be symptomless and discovered only at autopsy. If symptoms are produced, they are usually manifest early in life and are most likely to be those of a partial or complete intestinal obstruction. This is usually due to a submucosal or intramural cyst that enlarges at the expense of the intestinal lumen. They may be associated with and be the actual cause of an intussusception as in the case reported by Bazin and the second case in this report.

In any event, pain is likely to be the early prominent complaint and this is colicky in character, may be intermittent, and is usually in the right lower quadrant. Because of its close relationship with the bowel, the cyst may become infected and the clinical course will become correspondingly more severe. In the case reported by Theis there was a small opening in the cyst wall allowing communication with the bowel

lumen. This allowed drainage of the cyst cavity and prevented retention and its consequent greater enlargement.

A palpable tumor mass has been present in many of the reported cases. The size, location, consistency, and local tenderness will vary greatly with the conditions of obstruction and infection present. The conditions most likely to be confused with enterogenous cysts are appendicitis, appendiceal abscess, intussusception, and other types of intestinal obstruction, abdominal tumors, and ovarian cysts.

These cysts are a surgical problem. While it would be ideal to remove only the cyst without entering the bowel lumen, its wall is so intimately attached to the wall of the bowel that this is practically impossible. Resection of the bowel and its contained cyst with end-to-end or side-to-side anastomosis is the method of choice. This is not always possible in duodenal cysts, in which removal of the involved bowel would damage the common and pancreatic ducts. Here attempts have been made to drain the cysts externally but they tend to recur. C. E. Gardner devised an interesting method of solving such a problem in what he calls "internal drainage" of the cyst. An incision is made into the cyst without entering the duodenal lumen. The cystic content is expressed and an anastomosis is made between the cyst and a more distal portion of the duodenum.



Fig. 3. The enterostomes cyst in Case together with the resected portion of the ileum, the cecum, and the ascending colon.

or jejunum thus instituting continuous drainage of the cyst, keeping it collapsed and preventing it from interfering with the lumen.

CASE. D. P. referred by Dr. Robert A. Black, as boy of 6 years, when he entered Mercy Hospital, April 25, 1911. His birth had been at full term, with normal delivery. His babyhood was uneventful. He had had no acute infectious diseases. His tonsils had been removed. Four weeks before admission he had had an acute attack of abdominal pain followed by nausea and vomiting and difficulty in securing bowel movement. Since this attack there had been persistent and troublesome constipation. Ten hours before admission similar but more severe attack had begun. No cathartic as given but his mother gave him enemas without result. The pain and vomiting persisted and upon admission he appeared extremely ill. There was moderate abdominal distention and tenderness which extended across the entire lower abdomen and slightly higher on the right than the left side. There was no suggestion of mass in this area but the findings were not definite. Rectal examination as not informative. The temperature was 101.4 degrees and the pulse 90. The white blood count was 9,000. There were no significant urinary findings. Both acute appendicitis and acute intestinal obstruction were considered and operation indicated.

Operation revealed the sigmoid twisted upon its mesentery to form a kink. The mass was incarcerated in the pelvis. The obstruction to bowel lumen was complete and the circulatory interference extensive as evidenced by the edema, the discoloration, the beginning necrosis in the small oiled loop, and the presence of bloody fluid in the pelvis. Immediate improvement as noted when the loop was brought up out of the pelvis and the volvulus corrected.



Fig. 4. Same as Figure 3, with cyst opened.

The appendix was distended and bled near its base and it was removed. At this time it was noted that the cecum seemed peculiarly thickened and suggested a double-like feeling, but in the presence of apparently more important pathology no other attention was paid to it. The boy made a good recovery and left the hospital on the twelfth postoperative day. During the succeeding summer and autumn he appeared in good health. He was unusually active and sturdy even for a boy of his years and it was at all times difficult to curb his athletic activities.

On November 3, 1911, approximately 6 months after leaving the hospital, in play with other boys on the lot, he was dragged by his feet in prone position, as he stated.

He stated he admitted suffering slight injury at this time and on the following day began to have cramp-like abdominal pain. A few hours later nausea and vomiting began and persisted, with increasing lower abdominal pain, no bowel movements, and slight fever. He was brought to the hospital on the morning of November 4. He appeared extremely ill. There was more muscle rigidity and greater local tenderness, especially in the right lower quadrant, but less distention than at the time of his previous hospital admission. Rectal examination was negative. Acute intestinal obstruction was diagnosed and immediate operation as advised. At operation it was discovered at once that there was no recurrence of the former volvulus. The transverse colon was collapsed and the ileum was distended. Some adhesions, mostly recent, were found in the region of the ileocecal valve. The cecum was enlarged and thickened and had the feeling and appearance of an intussusception. All attempts at reduction of this as first supposed to be intussusception proved ineffectual. A longitudinal incision was made through the antimesenteric surface of the cecum and closed and filled with serosa.

and without communication with ileum or cecum was found. The pus seemed due to a colon bacillus infection. The cyst was 10 centimeters in length and 6 centimeters in greatest diameter. It occupied and filled the cecum in such a manner as completely to obstruct the ileocecal valve. The antimesenteric wall of the cecum and the wall of the cyst seemed one structure and could not be separated. From this point it bulged into the lumen of the cecum, there being no attachment of the cyst wall to the inner wall of cecum on the mesenteric side. The lining mucosa of the cyst seemed like that of the cecum. It being impossible to dissect the cyst wall from its cecal attachment, a resection of the cecum with the cyst and the ileocecal valve was done. After removal of this V shaped mass with the point of V on the mesenteric side, the ascending colon and the ileum were sutured together at almost a right angle. For decompression purposes, an ileostomy was performed 8 inches above the resection and a rubber tube was inserted. His convalescence was by no means uneventful and the tube in the ileum soon proved its usefulness. There were small natural bowel movements on the fifth and ninth postoperative days, and the tube was removed from the ileum on the tenth day. The fistula healed spontaneously and he left the hospital in good condition on the twenty-fifth day. He has been in excellent physical condition since. In the summer of 1936 he returned to the hospital for 10 days for repair of the weakened abdominal wall.

The report of the pathologist on the cyst wall which had been removed revealed "a non specific suppurative enteritis, lined with a membrana propria and infiltrated with polymorphonuclears, fibrin and hemorrhage with some destruction of the mucosa."

In summary, the interesting aspects presented by this case are (1) Two intestinal obstructions of entirely different types occurred inside of a 6 months' period. Volvulus is not a very common cause of intestinal obstruction. May the presence of the enterogenous cyst in the cecum, by causing partial obstruction and abnormal influence on peristalsis, or in any other manner have been a factor in producing the volvulus? (2) The enterogenous cyst, superinduced by trauma, had become acutely infected with a colon bacillus infection. The closed sac, like an obstructed and infected appendix, had become distended by the products of infection and had acted as a mechanical cause of an acute intestinal obstruction.

CASE 2 (This case is reported by Dr. Lester R. Dragstedt) W. M., a baby boy of 8 months, was admitted to Billings Hospital December 9, 1936. His birth had been by normal delivery at full term. His weight at birth was 7 pounds 6 ounces. He had been artificially fed with an evaporated milk formula with added dextra maltose. At 6 months he had had a left otitis media and the ear drained for 3 weeks. The infant was otherwise well until 2 weeks before admission when he began to have abdominal pain, characterized by drawing up of his legs and crying. He vomited a part of his feedings but no fever was noted and

the stools were normal. The attack lasted only a day but a week later recurred for a single day. Two days before admission the vomiting began again and persisted. The bowels became constipated and enemas produced a small amount of fecal material with no blood noted. Examination upon admission showed a well developed and well nourished infant who cried intermittently as if in pain. The examination was essentially negative except for a sausage shaped mass felt in the transverse position above the umbilicus. The rectal examination was negative. A barium enema showed some obstruction to the barium in the transverse colon which gave way under pressure. The vomiting continued and 2 days after admission an exploratory laparotomy was done by Dr. Dragstedt. A tumor mass was found in the ileocecal region. An intussusception was present and was partially reduced. A tensely distended oval mass about 4 centimeters in diameter, was palpated in the ileocecal region. This mass proved to be a cyst within the wall of the ileum, and was removed with 6 inches of ileum, cecum, and ascending colon. A lateral anastomosis between the proximal ileum and transverse colon was performed. The child had a rather stormy postoperative course, complicated by acute dilatation of the stomach. This was relieved by a Wangenstein apparatus. The stools became normal one week after operation and he made an uneventful recovery, being discharged December 23, 2 weeks after admission. The final diagnosis was (1) enterocystoma of ileum, (2) intussusception, secondary to enterocystoma of the ileum.

The baby continued to do very well for 10 days following his discharge from the hospital. He then began to vomit his feedings, and after this had persisted for 2 days he was returned to the hospital January 4, 1937. He seemed moderately ill and was somewhat dehydrated. There was no abdominal rigidity but an indefinite mass was felt in the right upper quadrant. The rectal examination was negative. A barium enema revealed a complete obstruction in the proximal transverse colon at the site of the anastomosis of the colon with the terminal ileum. Operation revealed an intussusception of the ascending colon into the transverse colon, producing the block obstruction between distal ileum and transverse colon. This was reduced and the end of the ascending colon was sutured to the anterior abdominal wall to prevent further intussusception. He had a rather uneventful subsequent hospital course. Vomiting did not recur, stools again became normal, and he was discharged 13 days after admission. The final diagnosis was acute intussusception. Since his last discharge the child has done very well with no recurrence of the vomiting.

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CANCER OF THE BREAST

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WHEN a diagnosis, absolute or presumptive of cancer of the breast is made the problem arises as to the way in which this condition can best be treated. The importance of this question becomes strikingly apparent when we realize that approximately 40 per cent of the total mortality from cancer in the female is due to cancer of the breast. The first objective of this paper is to stress the prevailing conflicting ideas of treatment of this condition the second objective is to emphasize the type of operation necessary for the highest percentage of cure the third is an attempt to correlate with the operation the best method of radiation.

Should patients suffering from this condition be subjected to a mutilating operation? Should they receive radio-active therapy before or after operation? Should this therapy include sterilization? The large clinics as well as individual surgeons have given diverse answers to these questions. Excerpts follow from personal communications on this subject received from the heads of some of the more important clinics in this country.

The chief of one clinic replies to our questions as follows:

"We feel that pre-operative x-ray is not indicated in the majority of cases because it prolongs the time in which the patient must endure the thought of operation, makes the operative procedure more difficult, and has not proved itself to be of sufficient value to warrant the delay. We do use postoperative x-ray very consistently particularly in Grades III and IV although Dr. _____ report of large series of cases is not too encouraging. The suggestion from Herrell's work that deep x-ray treatment with the idea of stopping ovarian function in women with carcinoma of the breast, who are still menstruating, seemed to be of sufficient importance to warrant selecting a few patients to their late thirties and early forties for this study. However the data that have accumulated to date are so meager that the radiologists are not willing to commit themselves. They do say however, that they are not particularly enthusiastic as their experience so far has shown very little difference in reaction of the two groups.

Reply No. 2

"When we last went over our cases of carcinoma of the breast we found that the pre-operative x-ray treatment seemed to offer a better percentage of possibilities for cure than the postoperative treatment of these tumors. We employ the pre-operative treatment much more than do the postoperative. In pre-operative treatment find little difficulty in controlling the patient and in keeping

up her morale during the wait after irradiation is completed and until the operation takes place. However, are strongly in favor of the complete operation without any compromise after this pre-operative irradiation, as found so often that the glands show involvement and if the breast alone is removed we are left behind tumor tissue in the axilla. We do not follow postoperative irradiation as a routine, but use it for metastases if they appear, and use the treatment then. We do not make a routine practice of sterilizing the patient after operation. We have done this in a few cases but only after careful consultation and when there was a very definite indication for this procedure.

Reply No. 3

"We do treat all of our radical mastectomies with post-operative deep therapy giving at present 2,400 roentgen units to 3 areas, that is the axilla, breast area, and supra-clavicular area. We are also carrying out x-ray castration. We have no statistics to prove that it could be benefit, yet we have a very definite opinion that it is the thing to do and that it is extremely helpful.

Reply No. 4

In regard to your first question, we have been employing deep x-ray therapy postoperatively as an almost routine measure for the past years and more. Statistically we are thus far unable to show any increase in 5 year cures among those who did and those who did not have x-ray treatment. However, our experience is in line with work that has been published indicating that in patients who had had radical operations and in whom axillary gland involvement was found and who ultimately died of cancer slightly longer span of life as reported by x-ray treatment. We try to give the x-ray treatment as soon as the wound has healed. In very few cases we have given x-ray before operation. These patients have been young women and thus far our end-results have been no better than with operation first and x-ray afterwards. In other words, neither procedure served to stave off the appearance of recurrent metastases more than 6 months. In regard to your second question, the answer is much the same as the matter of pre-operative x-ray. We have performed sterilization within the past year in young women with breast cancer shortly after their radical operations. Neither patient survived operation 6 months and both died with extensive metastases. So few trials, however, proving nothing and we intend to continue sterilization of suitable patients.

Reply No. 5

"You ask about my ideas on the treatment of carcinoma of the breast. I presume that there is no other field of surgical therapy about which I have less decision of mind than this. I have thought great deal about it and have tried to glean what I could from the opinions of others for the past few years, but I still do not know the answer. One difficulty is that statistics here are so variable, largely due to the constantly changing methods used by radiologists, and we have no statistics of value on any one type of therapy as the machines and the ideas of the radiologists have changed from year to year. We are carrying out

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the following plan during this present year. Patients with small tumors and without axillary metastases in whom the diagnosis is doubtful, are operated upon, cautery biopsy carried out, and if the results are positive, we do the radical operation. The radical operation is also carried out on those with small cancers without axillary metastases in whom the diagnosis can be made clinically. This group is given x ray therapy as soon as the wound will permit. There is a second group consisting of those who come in with far advanced or definitely established carcinoma of the breast with obvious axillary metastases, to which we are giving x ray therapy prior to operation. Following the disappearance of the reaction, they are then subjected to the radical operation. All patients who are still menstruating are sterilized with x ray. Patients who have distant metastases and do not fall in the operable class are treated only by x ray. There seems to be no particular rhyme or reason to this procedure but we hope by following it consistently we may get some statistics that may be helpful to us in the future. I am sorry I cannot be more positive in my reply but frankly, I do not know of what value x ray is in the treatment of carcinoma of the breast nor do I have any opinion concerning the type of therapy that should be carried out."

Reply No 6

"My own feeling is that moderate pre-operative radiation will increase the number of permanent cures. I think the way this works is by devitalizing, more or less, the carcinoma in the operative field. Then probably at the time of operation, carcinoma will be present in the glands, but very few cells will be in the process of migration and, therefore, there will be less probability of seeding through the operative wound. I still hold to the idea that carcinoma which has extended beyond the actual limits of the operative field cannot be cured. Now, as to postoperative radiation, I am not so keen about it because if pre-operative radiation has already been given, to continue will increase the likelihood of edema. I also feel that it will take just as much radiation to kill any cell, no matter how small the group, as it did before operation. As to sterilization of these patients, I have not done so, and there seems to be little tendency to sterilize in this community. My own feeling is that it is somewhat comparable to small doses of x ray, that it is possibly an aid, but I don't believe it will kill a single carcinoma cell. For palliative use, it might be advisable, but I have had no experience with it."

Reply No 7

"Personally, I have never been able to develop any enthusiasm for x-ray treatment of these cases and I have not enough cases to give statistics. My idea is this. If I see a perfectly definite carcinoma of the breast without evident glandular involvement, I believe in an immediate and most radical operation possible. If during the course of this operation we find any involved glands, I believe in postoperative x-ray treatment. Whether this does any good or not, I have never quite been able to make up my mind. In cases on the borderline as to operability with possible involved glands in the axilla, I believe very thoroughly in pre-operative x ray treatment, a thorough course with radical operation in about 6 weeks. I have never resorted to sterilization of patients who are still menstruating although from the reports of improvement after x ray treatment of the ovaries in the case of bone metastasis, I believe it might be a good thing at all times. In regard to the inoperable cases, I think all our ideas are the same, that x-ray treatment offers a chance of palliation. Personally, I have never seen a cure from x ray treatment

alone. I know that x-ray men claim this, but I have never seen the cases presented. I still feel that the most thorough radical operation that can be done at the earliest possible moment is the best treatment. When you can call a case cured I do not know, as you know Dr. Finney has had a case recur in the wound after 24 years, and I have had one after 20 years.

Reply No 8

"(1) If the breast contains all the carcinoma present, in other words, if the nodes in the axilla are negative for cancer, then a radical amputation, including both pectoral muscles and the axillary contents, is employed and post-radiation is not done. (2) If the nodes in the axilla are positive, even one node positive, then the patient is thoroughly radiated after the operation, about 2,400 units being given in the supraclavicular space and over the chest wall and axilla in equal doses of about 800 units each. The dosage of 800 is placed in these three areas although it may be distributed over 10 days' or 2 weeks' period of treatment depending on the patient's reaction to radiation. (3) If I have reason to suppose that it is inoperable that is, if judged by supraclavicular nodes that are already present, fixation of the tissues of the axilla or definite metastatic nodules that can be seen in the x-ray films, then, no operation is done and the patient is treated by radiation only.

"I do not employ x ray therapy pre-operatively under any circumstances, except when a patient that has been considered inoperable has responded well to radiation with the disappearance of previously fixed tissues, then 8 weeks after the last radiation, a radical operation may be employed. This is a rare opportunity and not often met. All patients with cancer of the breast who have not reached the menopause we do sterilize, or at least ablate ovarian function by x-ray therapy. I am not sure but what we may change our views on this point as ———, apparently, is bringing out in a series of studies that there is no evidence that this really makes any difference to the ultimate cure of the patient. However, we shall continue to do it until his figures convince us otherwise."

Reply No 9

"We try to use both pre- and postoperative irradiation, as well as the implantation of radium under the flaps at the time of operation. Since 1930 we have been sterilizing by irradiation the patients below the menopause. During the past 2 or 3 years we have also been irradiating the pelvis of patients beyond the menopause. This latter procedure is probably due to the fact that we had one case with metastases in the pelvis who had an ulcerating inoperable carcinoma of the breast and the patient was past menopause. We irradiated the bone metastases in the pelvis with the hope of relieving the pain of the metastases. Much to our surprise the growth in the breast receded and improved wonderfully, in fact, it practically disappeared. However, the patient died of malignancy, and I do not think for one moment that the irradiation of the pelvis prolonged her life. As you probably know, other men have had somewhat the same experience.

"I am afraid I have reached the point where we use irradiation because if it can be done sensibly it will do no harm and might do some good. I am sure of one thing, and that is unless irradiation is done properly it will do a lot of harm. I am also confident that unless the surgeon watches himself mighty closely he will not do as thorough a Halsted operation as he should do. Another reason for sterilizing the younger group of women is to prevent future pregnancy, for it has been our observation that lactation

In remaining breast in patient who has already shown tendency to develop malignancy is dangerous.

Many variable factors are responsible for this difference of opinion among which are the length of time the tumor has been present the activity of the mammary gland the degree of outlying involvement, the microscopic interpretation of borderline tumors, the type of cancer in individual cases, selection of cases for operation, operative technique and x-ray technique.

Most important of these factors is the time that has elapsed since the appearance of the tumor a good prognosis being in inverse proportion to the length of time the tumor has been present. Private patients because of their greater intelligence education, and better economic status will present themselves for examination sooner than those admitted to the public wards. Statistics relating mainly to private patients will, therefore show better results. In the second place the activity of the mammary gland in each patient must be considered the cancerous growth proceeds more rapidly in a young woman than in an older one, and pregnancy and lactation likewise hasten the extension and dissemination of the growth.

The third factor of immense prognostic value is the degree of outlying involvement about the original growth. Cancer of the breast metastasizes early and spreads widely. Surgeons no longer need proof that the slightest delay is dangerous. It has been our own experience that of the patients who come under observation with cancer of the breast only 20 per cent are free from metastases that can be demonstrated either grossly by x-ray examination, or by microscopic examination of the tissues following operation. It is doubtful whether much change in the ultimate result has occurred since 1907 when Halsted wrote (5). Other things being equal the prognosis is quite good in the early stage of breast cancer two in three being cured and bad three in four recumbent when the axillary glands are demonstrably involved.

In spite of admirable work on the subject, classification of the degree of malignancy of a cancer according to the appearance of the individual cell is unreliable. It is, however a well established fact that certain cancers of the breast vary in their degree of malignancy according to the alignment and distribution of the invading cells. An excellent pathological classification of cancer of the breast is given by MacCallum (1) tumors of stratified epithelium (2) tumors derived from the cells of the acini of the gland (3) tumors derived from the ducts and their branches and (4) colloid tumors.

The tumors of stratified epithelium may begin as an eczema-like alteration of the nipple and adjacent skin (Paget's disease) or they may arise in the substance of the breast but are nevertheless composed of squamous epithelium. Very frequently a tumor which is composed of these same squamous epithelial cells may be palpated deep in the breast in a patient who shows such an ulceration about the nipple. These changes in the breast are malignant and demand a radical operation.

The tumors derived from the cells of the acini of the gland are the most frequent and the most malignant. They may be made up of abundant, soft masses of cuboidal cells, with relatively little stroma, so that soft, cellular masses are formed (medullary cancer) or they may be composed of a relatively greater amount of stroma and comparatively few cells to form a dense, scar-like fibrous mass (scirrhous cancer). This latter type grows and metastasizes much more slowly than does the softer form so that such a tumor may exist for years nevertheless, this tumor is the most treacherous and such cases have the poorest ultimate prognosis.

It is true also that in cancer elsewhere as in cancer of the stomach or colon the large fungating growths, wicked in appearance, may be cured more often than the small scirrhous ones that seem more readily resectable. Having heard a quotation in this connection attributed to one of the Doctors Mayo I wrote to their clinic in Rochester Minnesota, and was rewarded by the following courteous note from Dr W J Mayo.

"Your letter of November 22, 1938, has been referred to me for answer. The statement about which you inquire is easier to cure cancer that is coming towards you than cancer that is going away from you, was made to me many years ago by my father, Dr William Worrall Mayo, then as boy I, as accompanying him on his professional visits. In other words, he believed that metastatic growths often develop in unexpected situations remote from adhesion carcinoma. My father made the comment in relation to the case of lady whom I knew very well, who had fungating carcinoma of the cervix, his feet discharges and bleeding. This as in the days before radium and x-ray. The patient was in poor condition and father used the actual cautery, the old fashioned soldering iron, very effectively and the patient remained well since she was an acquaintance, I am able to follow the case closely for number of years. It is interesting to my brother and me that after many years this statement of our father should come back to us.

Tumors derived from the ducts and their branches are more like the cylindrical cell cancers or adenocarcinomas common elsewhere in the stomach, the gall bladder the bile ducts, the large intestine the body of the uterus, the prostate and the bronchial mucosa. They are com-

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posed of tubular epithelial structures that are often associated with cysts. Another type, which has a relatively good prognosis, shows canals lined with many rows of irregular cells. These were called adenocarcinomas by Halsted, and have also been referred to as comedo carcinomas, since masses of cells may be expressed like the material from a comedo or black-head in the skin. Colloid tumors arise from the epithelium of the acini but present, as MacCallum describes, an extraordinary gelatinous metamorphosis of the stroma. They are uncommon, metastasize rarely, grow slowly, and are relatively benign.

One pathologist after examining a microscopic section of the breast which shows only a few epithelial cells escaping into the stroma or filling a small duct will call the tumor benign, a papilloma, chronic cystic mastitis or adenosis, another pathologist will interpret the same tumor as a cancer. As a consequence, a higher percentage of cures in the operative treatment of cancer will appear in the statistics of the investigator who classified the tumor as malignant than in the statistics of the investigator who considered such a tumor to be benign.

One surgeon may refuse to operate in any but the most favorable type of case. Naturally his percentage of cures will be higher than those of a surgeon who will operate even when the condition is far advanced. The record following operation, in terms of a permanent cure or even a 5 year cure, is not a bright one. Nevertheless, patients who have an obviously malignant mammary growth and hard, palpable glands in the axilla are not infrequently completely cured by our present operative attack. Sowers, in 1905, subjected to operation a patient of 66 years who had a large tumor of long duration in her left breast which had ulcerated through the overlying skin (10). There were regional metastases to the left axilla and neck. A radical Halsted mastectomy with an Ollier-Thiersch graft operation was performed, requiring over 4 hours for its completion. Not only was a very large area of skin removed, but the chest wall, left axilla, and left supraclavicular regions were meticulously denuded of all tissue. The patient was living and well in June, 1931, at the age of 93. Examination of the specimen removed showed the tumor to be a large infiltrating scirrhous carcinoma which invaded not only the overlying skin and subcutaneous tissue but also the underlying pectoral fascia and muscle. These patients afford the encouragement that stimulates one to perfect his present strategy and seek new methods to attack the problem more successfully.

We do not wish to imply that every patient who suffers from cancer of the breast should be subjected to a radical operation regardless of the extent of the lesion. Those who show distant metastases, deep fixation of the cancerous process to the chest wall, or extensive involvement of the supraclavicular area are obviously not subjects for radical resection. However, many cases that at first appear inoperable will on more careful examination be found to be operable, another group of patients in an advanced stage will be so improved by pre-operative radiation that radical resection is indicated. Unless, therefore, every possibility of cure seems to have departed, the patient should be given the chance offered by operation.

It must be borne in mind that the so called radical operation varies greatly in its completeness and therefore effectiveness according to the individual operator. This fact causes a difference in the reports of the ultimate operative results. A carefully performed, completely clean dissection—with the purpose not to leave behind a single cancer cell—is requisite and necessary for cure. Nevertheless, it is rarely properly accomplished. Fortunately, patients may be subjected to this operation, which may last several hours, without severe shock, so that there is adequate time for its performance. The avoidance of contamination with cancer cells, the absolute control of hemorrhage, and the complete dissection are discussed in the description of the operation.

The effect of treatment with irradiation, either pre-operatively or postoperatively, cannot be evaluated from reports in the literature unless standardized doses have been used and unless a large number of patients have been subjected to an identical therapy. The literature on this subject, in most instances, employs the term "x-ray treatment" so loosely and the patients have been treated so dissimilarly that a just appraisal of this method cannot be made. It is a well established fact, however, that radiation shows certain definite effects when employed against cancer of the breast. It will shrink the original growth, sometimes the reduction is so great that the primary tumor cannot be recognized. Likewise, radiation will shrink metastatic lymph nodes, and even the metastases in bone will be reduced and the accompanying pain greatly alleviated. Metastatic skin involvement can be controlled almost completely by its use.

To date many series of patients have been studied who were subjected to the radical operation followed by postoperative radiation. The effect of this radiation, taken as a whole, has

proved disappointing. Many believe that this therapy given after operation will at best prolong the life span only 6 months.

The pendulum has swung toward pre-operative radiation in an attempt to improve the percentage of cures. The usual pre-operative therapy is generally inadequate. According to E. B. Kelly the treatment should be carried out as if it alone were expected to cure the cancer. This will necessitate the production of erythema, even blistering of the skin before sufficient radiation reaches the deeper structures. This effect is obtained by the combination of cross firing by x ray and subsequent (or concomitant) implantation with radium or radium needles. In some cases the primary tumor disappears, as far as palpation goes, by x-ray cross firing alone but in a great many it does not, and these particularly should have the implantation as well as cross firing. If moderate radiation is of any value, we must conclude that very thorough radiation is of even more value but of course overdoing it would interfere with the subsequent operation. One must strike the balance at exactly the right point. The ribs and overlying tissues must not be damaged beyond their ability to recover. The purpose of this treatment is to inactivate the growth as much as possible and block off the avenues along which the cancer cells may spread. A type of cancer in which pre-operative radiation is certainly indicated is that in which there is much skin involvement, as in "crystalloid carcinoma." Here the rich lymphatic anastomoses in the dermis are so involved that a recurrence of the growth is likely to appear in the skin soon after operation unless radiation is given pre-operatively.

There are several inconveniences and disadvantages in pre-operative radiation. In the first place many times a positive diagnosis of cancer cannot be made until the tumor is removed at operation. In the second place the patient often will be unwilling to endure the delay in the removal of the cancer while waiting during the several weeks of the radiation treatment. The diminution in size or the disappearance of the tumor following radiation may lull the patient into a sense of false security so that she will decide against operative removal. Radiation is also said to cause scarring of the axillary tissues that renders the operative dissection more difficult. We have not found this to be the case.

In spite of the arguments that may be advanced against pre-operative radiation nevertheless, it is a weapon which has undeniable power. Although the properly executed radical operation is still our

most effective method of attack, this operative method alone while it can reduce local recurrences to a minimum has not prevented in patients, whose axillary glands are involved before operation, a distressing number of deaths from distant metastases. It is also true that postoperative radiation has not materially improved the percentage of cure. Radiation will, as we have said, cause extreme shrinking in the original growth in the breast and the involved axillary nodes. Our pre-operative procedure therefore is to inactivate the process as much as possible and to seal off the avenues of escape. At the present time, with all patients who have a growth in the breast which appears so obviously to be cancer that no preliminary local removal for examination is necessary we are first subjecting them to thorough pre-operative radiation then performing the radical operation as described, and following this up with postoperative radiation. Microscopic examination of a breast removed after pre-operative radiation shows complete destruction or disintegration of the cancer cells, shrinking of the remaining nuclei, and almost total absence of mitotic figures.

Should radiotherapy include castration or temporary ablation of ovarian function? This is a moot point. The chief arguments advanced in favor of such a procedure are that cancer of the breast seems to pursue a more rapid course in the younger woman that pregnancy occurring after an operative removal of a carcinomatous breast increases the possibility and speed of a recurrence that radiation of the ovaries in the presence of metastases will often decrease the size of the metastases, and that experimentally an increase in the incidence of carcinoma of the breast may be produced in mice by the injection of large quantities of the follicular hormone estrin. The argument advanced against ovarian radiation in the young woman is that the disagreeable menopausal syndrome is induced.

OPERATIVE CONSIDERATIONS

The story of the development of the present operation for radical removal of a cancer of the breast tells of the hopeless attitude shared by layman and doctor toward this condition until as recently as 45 years ago. In 1864 Halsted wrote (4) "Most of us have heard our teachers in surgery admit that they have never cured a case of cancer of the breast. The younger Gross did not save one case in his first hundred. Hayes Agnew stated in a lecture a very short time before his death that he operated on breast cancers solely for the moral effect on his patients, that he be-

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believed the operation shortened rather than prolonged life. H. B. Sands once said to me that he could not boast of having cured more than a single case, and in this case a microscopical examination of the tumor had not been made."

In all ages, however, occasional cures of breast cancer have been observed by reliable surgeons. Encouraged by these rare but positive cures, a school of surgeons headed by Volkmann devoted many years to this problem, and Volkmann's contribution in 1875 marked the beginning of a great advance. He was the first operator to advise removal of more than the breast itself when he stressed routine stripping of the fascia from the pectoralis major muscle "as for a classroom dissection."

"I make it a rule," Volkmann said, "never to do a partial amputation for cancer of the breast, but remove the entire breast even for the smallest tumors, and at the same time I take away a liberal piece of skin. The skin defect is, of course, very great when one operates in this manner, and the wound in consequence requires a long time for healing. Furthermore, in making the lower incision I cut right down to the pectoralis muscle and clean its fibres as I would for a classroom dissection, carrying the knife parallel with the muscular fasciculi and penetrating into their interstices. The fascia of the muscle is, accordingly, entirely removed. I was led to adopt this procedure because, on microscopic examination, I repeatedly found when I had not expected it that the fascia was already carcinomatous, whereas the muscle was certainly not involved. In such cases a thick layer of apparently healthy fat separated the carcinoma from the pectoral muscle and yet the cancerous growth, in places demonstrable only with the microscope, had shot its roots along the fibrous septa down between the fat lobules and had reached and spread itself out in flat islands in the fascia. It seems to me, therefore, that the fascia serves for a time as a barrier and is able to bring to a halt the spreading growth of the carcinoma."

Kuester, in 1883, agreed with the teaching of Volkmann that the fascia pectoralis should be removed with the breast. His assistant at Marburg, named Heidenhain, proposed cutting away the superficial fibers of the pectoralis major muscle. With reference to involvement of the fat which separates the breast from the pectoral muscle he said

"I am firmly convinced from what I have seen that carcinomata when they have actually made their way into the lymphatic channels, and such is usually the case, have invariably sent their outposts (Vorposten) at once to the surface of the muscle, no matter what the thickness of the layer of fat between the breast and muscle may have been, in other words, that a tumor, however freely movable on the underlying parts, has almost certainly advanced as far as the surface of the muscle."

Koenig, in 1885, in the fourth edition of his *Surgery*, said "When the fascia over the pec-

toralis muscle is diseased it (the fascia) must be removed."

Although Volkmann and Guessenbauer were the first to suggest exploration of the axilla in every case, Kuester was the first to recommend the systematic cleaning out of the axilla. Nevertheless, the operation even though improved was an imperfect one because it permitted the frequent division of tissues which are cancerous and did not give the diseased area sufficiently wide berth.

Halsted, as early as 1882, began not only to clean out the axilla in all cases of cancer of the breast but also to excise in almost every case the pectoralis major muscle, or at least a generous piece of it, and to give the tumor on all sides an extremely wide berth. He believed it was impossible to determine with the naked eye whether or not the disease had extended into the pectoralis muscle, and from careful microscopic examination of many very small cancers of the breast he was convinced that at the time of operation the pectoralis major muscle is usually involved in the new-growth. Up to that time no authority had suggested the advisability of always removing the pectoralis muscle or a portion of it in operation for the cure of cancer of the breast. In 1891 (3) his first description of his complete operation for this condition appeared in print. In 1894 (4) he published the results of the first 50 cases operated on by the complete method. He stated at that time

"The pectoralis major, entire or all except its clavicular portion, should be excised in every case of cancer of the breast, because the operator is enabled thereby to remove in one piece all of the suspected tissues. The suspected tissues should be removed in one piece (1) lest the wound become infected by the division of tissues invaded by the disease or the lymphatic vessels containing cancer cells, and (2) because shreds or pieces of cancerous tissue might readily be overlooked in a piece meal extirpation."

In 1894, Willy Meyer had independently come to the conclusion that the pectoralis major muscle should be removed at these operations, and he advocated taking the pectoralis minor also. Finally, Handley, in 1905, advised that the upper portion of the sheath of both recti muscles be included in the resection. All these fundamental steps are now included in the operation that is to be described.

No claim of originality is made for the following operation. The conception and the technical details are in principle those defined by Halsted in 1894. Unfortunately for many people, doctors as well as laymen, the radical breast operation means merely the removal of the breast, the

pectoral muscles, and the axillary glands. Great disappointment is experienced when the results of this procedure are not attended with the success expected. The reason for this is that, although the surgeon's strategy in attacking the problem may have been excellently worked out in advance, the correct tactics on the field of operation were not employed. It is the attention to fine detail at operation that will make the difference between success and failure, in other words, the application of *fundamental surgical principles*, namely (1) absolute asepsis (2) complete control of hemorrhage (3) sharp fine entirely thorough dissection and (4) gentle handling of tissues.

To facilitate this care in operative detail silk offers many advantages over catgut as a suture material. It is interesting to observe in the literature articles appearing with increasing frequency by surgeons who use catgut advocating the employment of catgut of smaller and smaller caliber indicating the trend toward a finer medium. In the first place silk is a finer more delicate medium with which to work and achieves more skillful, accurate results. After operating with silk and then employing catgut one has the sensation which he supposes must be that of a taxidermist in stuffing a tiger. Tissues can be tied with much force by catgut but dexterity and care must be taken with silk. This latter point is emphasized by the fact that silk is almost universally employed in operations where delicate technique is indispensable as on the brain and in nerve and tendon suture.

THE TECHNIQUE OF THE RADICAL BREAST AMPUTATION

1. Much has been written about the operative incision for a radical mastectomy and numerous designs have been contrived that will facilitate the primary closure of the wound. Many times these are not adequate and hinder thorough eradication of the growth or lead to contracture of the axillary fold so that there is much truth in Follis' remark that the initial incision should be made by one person and the closure of the wound by another. In practically all cases an elliptical incision, as illustrated in Figure 1 is the most satisfactory one. It permits a wide margin of safety about the growth gives the wide exposure necessary for dissection and affords a closure that shelters the axillary vessels and allows free motion in the axilla following operation. This initial incision, which includes the entire thickness of the skin, commences on the medial surface of the humerus, at the distal end of the insertion

of the pectoralis major muscle extends along the posterior surface of the edge of the anterior axillary fold which is formed by the pectoralis major muscle, forms a circle to surround the growth widely rejoins and is continued down past the costal margin near the midline to allow excision of the upper portion of the recti sheaths.

2. The peripheral edges of this incision in the skin are now dissected free of all subcutaneous fat so that a lateral and a medial skin flap are formed which show only a clean undersurface of derma for a distance of approximately 6 centimeters from each edge.

3. The cephalic vein is isolated as it runs up from the anterior surface of the humerus over the shoulder marking the division between the fibers of the pectoralis major and deltoid muscles.

4. After the fibers of the pectoralis major muscle are traced to the point of insertion on the humerus they are cut through at this point.

5. A complete deeper circle of incision is now made about the exposed wound which cuts through all the muscles involved. This incision first cuts the fibers of the pectoralis major muscle as they arise along the clavicle and proceeds from the lateral to the medial end of the clavicle.

6. This same muscular incision is continued down over the sternum and cuts away the pectoralis major muscle fibers completely as they arise from the sternum. The only arteries of any size encountered in this muscular incision are met with in the region of the second, third, and fourth costochondral junctions where arteries, which run to the pectoralis major muscle penetrate from the internal mammary artery.

7. The cut pectoralis major muscle is retracted laterally and inferiorly its costal fibers being cut cleanly away from the ribs as they arise. Care must be taken not to include the origins of the serratus anterior muscle.

8. The inferior end of this muscular incision includes about 6 centimeters of the upper portion of the anterior sheath of both recti muscles and the overlying subcutaneous tissue.

9. Attention is now directed to the axilla which is exposed by first cutting away the entire pectoralis minor muscle. Change is now made to an entirely fresh set of instruments, including scalpel, forceps, and clamps, to guard against contamination with cancer cells that may have been encountered in the muscular incision.

10. Next the rather dense fascia overlying the axillary contents is incised, and the axillary vein exposed. Posterior and slightly superior to the vein lies the axillary artery. Superior to both and at the same depth, lie the brachial plexus nerve trunks.

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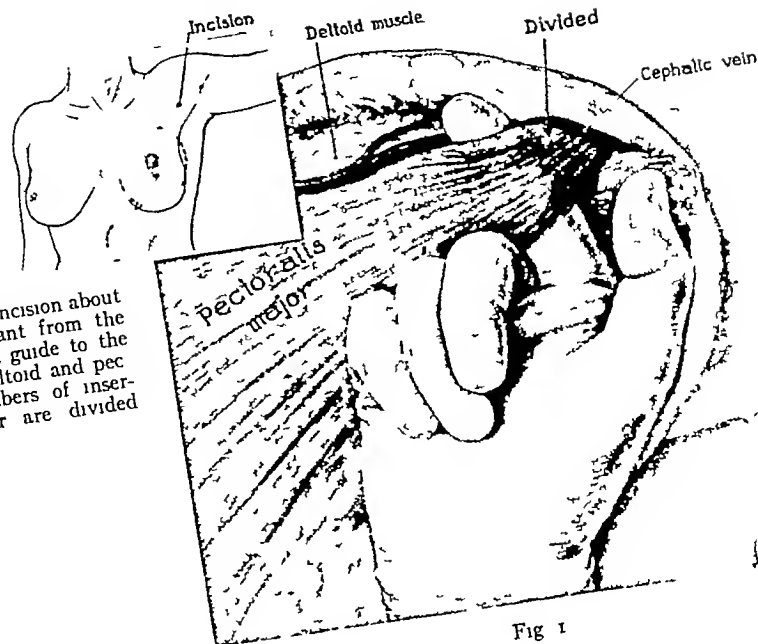


Fig 1 The periphery of the incision about the growth should be equidistant from the growth. The cephalic vein is a guide to the line of division between the deltoid and pectoralis major muscles. The fibers of insertion of the pectoralis major are divided over the inserted finger.

Fig 1

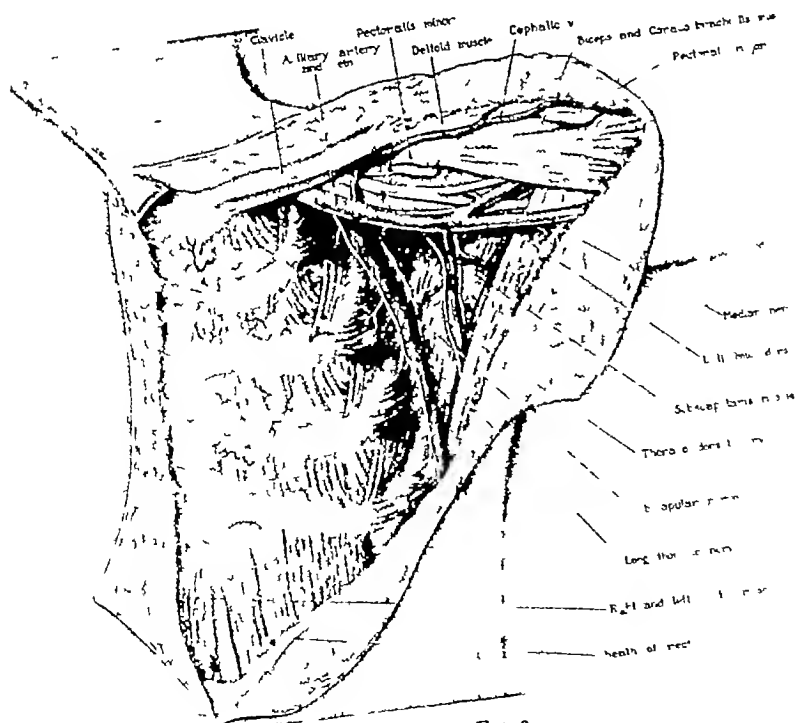


Fig 2 Dissection of every shred of tissue from the vital axillary structures. Sparing the vessels to the subscapular area helps prevent postoperative edema of the arm. The superior portion of each rectus sheath has been removed.

Fig 2



Fig. 3. The skin edges in many cases may be approximated completely without tension.

11 Now begins the most delicate and probably the most important part of the whole operation the proper dissection of the axilla. The operator proceeds from the proximal end of the axillary vessels and progresses distally and each individual branch of both vein and artery is traced close against the main vessels, dissected free of every shred of surrounding tissue, clamped with finely pointed artery forceps, divided and ligated. Clamping large bites of tissue as would be taken by including a venous and an arterial branch at the same time or by including the slightest bit of tissue other than vessel wall itself is absolutely wrong. Progressive individual ligation of each small vessel prevents a clamp pulling and tearing loose from the axillary vessels and thereby causing hemorrhage that obscures the field and prevents clean cut dissection.

12 The axillary vein and artery now stand out stripped absolutely bare of any overlying tissue from the proximal end at the ligament which marks the medial and superior angle of the axilla down to the distal end of the incision. All axillary branches have been tied off close to the vessel walls. Sometimes the wall of the axillary vein is invaded by metastatic growth. Should this be the case the vein should be resected without hesitation. Experience has shown that no harm will result from this procedure not even post-operative edema of the arm.

13 Attention is now directed to the posterior boundary of the axilla, the fibers of the latissimus dorsi muscle, the teres major and the subscapularis muscles. These must be completely exposed and freed of all overlying tissue just as the axillary vessels were cleaned. The long thoracic nerve running medially across these muscles to supply the serratus anterior muscle and the thoracodorsal

nerve running laterally to supply the latissimus dorsi muscle may in the majority of cases be spared after being dissected free of all surrounding tissue.

14 Vessels, nerves, and muscle boundaries of the axilla now stand out in clear relief as in a perfect anatomical dissection. The excised tissue including all the axillary glands, has been retracted with the pectoral muscles and the overlying breast the few remaining pectoralis major muscle fibers originating in the lower ribs are dissected off this entire mass is then removed *in piece* and discarded.

15 The axilla is now washed out with 2 liters of warm saline solution in order to remove possible contaminating bacteria and loose cancer cells.

16 Closure of the wound is commenced by suturing the lateral skin flap high on the chest wall to cover the axillary vessels and at the same time provide complete freedom of motion in the axillary space. Many times the lateral and medial skin flaps may then be brought together without tension along the entire length of the wound.

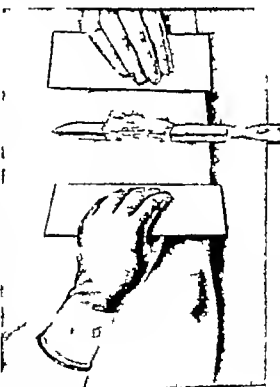


Fig. 4. The Ollier-Thiersch grafts are cut between boards which hold tense the skin of the thigh.

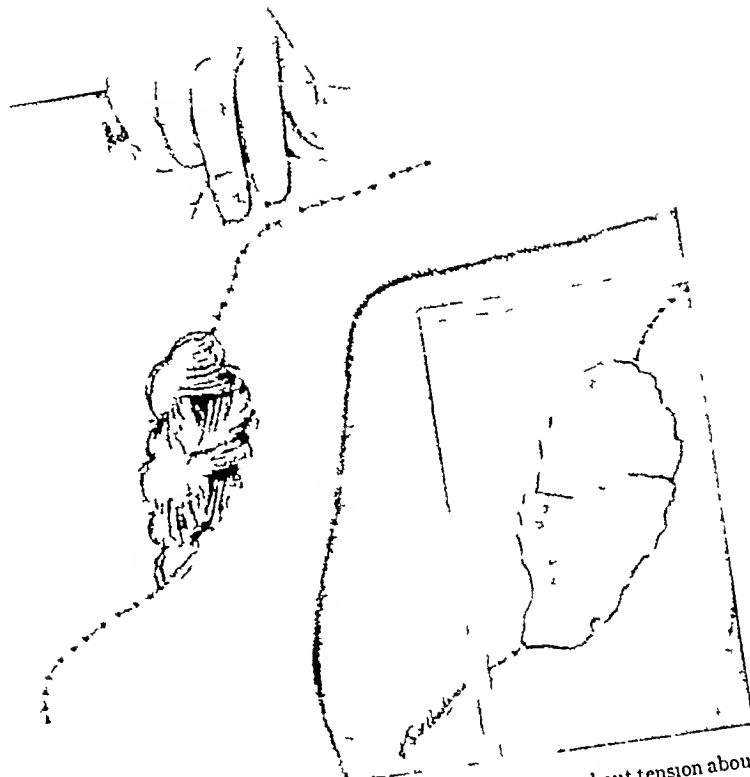


Fig 5 The skin is redundant in the axilla. It is approximated without tension about the defect. The insert shows 2 Ollier Thiersch grafts in place over the defect.

17 In most instances the edges of the skin cannot be completely approximated in the center of the wound without tension. In this case, closure is begun as previously stated by suturing the superior portion of the lateral flap high on the chest wall. The medial and lateral skin flaps are brought as near together as possible without tension, and the skin edges are closed with interrupted sutures above and below the defect. The skin edges about the defect are approximated as closely as possible without tension and sutured by interrupted stitches against the chest wall in this position. This procedure will leave an area of varying size on the chest wall not covered by skin. In almost every instance this area is smaller in size than the palm of one's hand. Immediate grafting should be done to cover this defect.

18 The skin of the lateral surface of the thigh, which has been cleaned previously and draped, is held taut between 2 thin, sterilized, wooden boards. With the long, thin, so called "catling"

knife, a graft or several grafts are taken from the thigh, placed epithelial surface downward on a gutta-percha sheet, and transferred to the area on the chest wall. These grafts are of the Ollier-Thiersch variety and are very thin, including only the epidermis and the top layer of the dermis. With some practice grafts 5 to 6 centimeters in width and almost any desired length are cut without difficulty. They are placed so as to cover the surface of the defect completely, the edges of the graft overlapping the edges of the operative defect. No stitches are necessary. This grafted area on the chest will be healed completely in 12 days' time. The method is so satisfactory that it is difficult to understand why most operators wait 10 days or 2 weeks before grafting a wound defect by a second operation.

19 Special dressing of the operative area is important. Both the area from which the graft has been removed and the one to which the graft has been transferred are covered first by silver foil. This protects the delicate surface and acts

as a mild disinfectant. A thin layer of vaseline gauze is then placed over the silver foil on each wound. The wound on the thigh is covered with sterile gauze and bandaged in the usual fashion. A sea-sponge, wrung out in saline solution is placed over the silver foil and vaseline gauze that lie on the grafted area on the chest wall. Some sterile gauze is put over this sponge and the dressing is anchored snugly against the chest wall by strips of adhesive tape. The sponge under this tape affords the correct amount of resilient pressure proper absorption of moisture and accurate fixation of the graft. The skin edges of the rest of the incision, which have been sutured together are dressed separately from the graft so that the dressing may be changed and the stitches removed after 5 or 6 days without disturbing the graft. The latter should not be dressed until from 10 to 12 days after the operation at this time healing will be complete.

10. The arm is never fixed against the side by bandaging. It is of the utmost importance that complete freedom of motion in the shoulder joint be permitted beginning on the day of operation.

SUMMARY

A few impressions stand out in this whole disputed question of cancer of the breast.

1. The last significant advance in the struggle was made in 1894 when Halsted described his complete operation. Only strict adherence to the details of this operation will give the percentage of cure he obtained.

2. Radical resection of the breast according to the painstaking technique described is the most effective weapon against cancer of the breast.

3. While a percentage of cure of approximately 75-80 may be achieved through a painstaking operation in patients who have no metastases, the figure drops to about 25 per cent in those patients who already have metastases. In 80 per cent of the patients presenting themselves for examination because of a lump in the breast metastases have already occurred.

4. Radiation following operation has failed thus far to increase perceptibly the percentage of cure.

5. Because of the still unsatisfactory percentage of cure in patients suffering from cancer of the breast with metastases who have been submitted

to a radical operation plus postoperative radiation, and because pre-operative radiation is known to bring about marked reduction in size of the original growth and of the glandular metastases, adequate pre-operative radiation should be employed in many cases.

6. Radiative castration of the younger woman suffering from this condition is a logical procedure.

7. The present method of treatment is as follows:

a. When a breast tumor is obviously benign or when there is justifiable doubt as to its malignancy it is removed locally but with a wide margin using the cautery throughout. If this tumor at the time of operation is found by microscopic examination to be malignant, the patient is subjected immediately to the meticulous radical resection as described. Postoperative radiation is given whether the axillary glands are found to be involved or not involved.

b. When a breast tumor before operation is obviously malignant pre-operative radiation is given daily for a period of 10 days. After an interval of 6 to 8 weeks the radical resection is performed. Postoperative radiation is then instituted.

c. Ablation of the ovarian function by radiation is recommended for those women with cancer of the breast who are still menstruating.

d. When a breast tumor has already metastasized to distant foci and an operation is, therefore, useless, radiation alone is given.

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TRAUMA TO THE KIDNEY

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OWING to its well protected position, the kidney is not frequently subject to trauma. However, such an injury, when it occurs, is of particular significance on account of the great vascularity of the organ and on account of its important excretory function.

Hamilton Bailey found that only 135 instances of renal trauma had been treated in the London Hospital during a period of 21 years, 108 of the patients suffered from injury to the kidney alone, and 27 had trauma to other organs as well as to the kidney. In 80 per cent of the patients the blow struck the posterior or lateral aspect of the trunk. The posterior surface of the organ was as frequently injured as the anterior, rarely was the renal pedicle completely torn across. Lardenois found that renal injury in 45 of 770 patients, 4.8 per cent, was caused by a blow on the anterior abdominal wall. Kuester proposed the theory that rupture of the kidney results from hydraulic pressure acting through the renal vessels and pelvis causing the organ to burst along lines radiating from the hilum toward the ribs. However, maximum impact against the lower ribs. How- ever, such an explanation seems unnecessary as the mechanism is adequately explained by the direct effect of trauma to the loin or flank.

At times renal trauma is accompanied by fractures of the lower ribs. Morris stated that fractures of laceration of the kidney. We have not observed this type of injury and believe it unlikely to occur as the twelfth rib extends away from the vertebrae at such an angle and is so held by the powerful costovertebral ligaments that the fragments would be driven into the kidney only by an unusual penetrating force. Contusion or rupture of the kidney may accompany fractures of the vertebrae or bony pelvis. However, injury to the urinary bladder is much more frequent accompanying fracture of the pelvis.

Spontaneous rupture of the kidney occurs only when it is diseased. Wade has reported an instance of spontaneous bilateral rupture in acute parenchymatous nephritis. Connell found in the literature 30 records of spontaneous rupture of

the kidney caused by one of the following conditions: arteriosclerosis, nephritis, neoplasm, tuberculosis, abscess, calculus, infarct, polycystic disease, and congenital solitary kidney. Rupture of a hydronephrotic kidney after retrograde pyelography has occurred. Bugbee quotes Voit with reference to a woman who felt a severe pain in the right side while dancing. Shortly thereafter, severe hematuria set in and occurred intermittently for 2 months. At operation a suppurating perirenal effusion and rupture of the kidney was found.

PATHOLOGY AND PATHOLOGICAL PHYSIOLOGY

The pathological conditions which are found at operation or at postmortem examination depend on the extent of the injury. The following is suggested as a classification for traumatic lesions of the kidney.

- 1 Contusion of the parenchyma without rupture of the intrinsic capsule or of the renal pelvis,
- 2 Contusion of the parenchyma with rupture of the intrinsic capsule and consequent extravasation of blood into the renal fossa,
- 3 Contusion of the parenchyma with injury extending into the pelvis,
- 4 Complete rupture of the kidney with laceration extending through the capsule, cortex, medulla, and into the pelvis.

Contusions and lacerations of the renal parenchyma show a considerable amount of edema at their periphery if seen soon after the injury has been sustained. The pressure from blood clots often tends to distort adjacent structures. The damage done by the trauma may extend as a result of thrombosis of vessels. As a consequence of the infarction thus caused, the amount of destruction of renal parenchyma is greatly increased. Urinary extravasation into the perirenal tissues may occur, and a continued flow of urine may increase the damage further. When extravasation of urine has occurred, infection is apt to supervene, as a result of the invasion of bacteria, and a huge perirenal abscess or dissecting cellulitis may be a subsequent complication. Furthermore, infarcts within the kidney may become infected and produce abscesses. From the clinical observations in this and other reviews, it is apparent that the degree of impairment in renal function immediately after the injury to the kidney is



Fig. Intravenous urogram 6 days after injury in Case 4 showing prompt satisfactory excretion from the left kidney. There is no renal shadow inside on the right and the right psoas shadow is obliterated. There is no excretion from the right kidney.

often greater than can be accounted for by the amount of tissue destroyed. The edema and impairment of function resulting from pressure of blood clot offer anatomical explanations for most

of this diminution in renal function. It seems necessary however in some cases to postulate a further reflex mechanism as an explanation for a part of the changes. This question has been investigated experimentally by Powers, who has studied the effect of renal trauma on the function of the remaining kidney of rabbits after unilateral nephrectomy. The impairment of renal function, when moderate trauma was used, was transitory and in 10 to 14 days the function of the kidney had returned to normal. In another series of experiments severe injury was inflicted on one kidney of normal rabbit there followed a rise of the non-protein nitrogen of the blood and a slight diminution in the total phenolsulphonphthalein excretion for several days after this the total renal function returned to normal. After 8 days the uninjured kidney was removed and the traumatized organ was sufficiently recovered to continue maintenance of renal activity at a satisfactory level. Prompt functional recovery was considered to be the result of rapid regeneration of tubular epithelium. He suggests that the majority of patients having suffered unilateral renal trauma may be treated conservatively with the expectation that the injured kidney will recover sufficient function to become a useful organ. This remarkable ability of the kidney to improve in function is well illustrated by our Cases 2, 3 and 6. Anatomically the period of progressive improvement corresponds to the period during which edema is subsiding and blood clots are being organized or removed after this the vascular circulation tends to return to normal.



Fig. This shows the ruptured kidney and many areas of discoloration that correspond to areas of infarction. (Case 4.)



Fig 3 Retrograde pyelogram, Case 2, showing extravasation of the opaque material into the renal parenchyma and renal fossa on account of complete rupture of the kidney



Fig 4 Intravenous urograms 2 years after drainage of the ruptured right kidney are normal except for a dilatation of the lower calyx which was the site of injury (Case 5)

The processes of repair after injury of the kidney consist of organization of infarcts, replacement of hemorrhages by fibrous tissue, and regeneration of tubular epithelium. There is considerable contraction of the scar tissue which causes bizarre distortion of the renal outline. In 2 of the cases of this series there was a complete separation of two portions of the renal parenchyma. Two of our patients developed renal calculi several years after their initial injury. It is to be remembered that large blocks of renal tissue cannot be repaired by regeneration, but the mechanisms here outlined are sufficient to account for a considerable improvement in renal function which may be maintained indefinitely.

DIAGNOSIS

In establishing the diagnosis of injury of the kidney and in determining the course of treatment to follow, one must evaluate the extent of damage to the organ. This may be accomplished by correlating the history and the findings upon repeated physical examination, urinalysis, daily measurement of the fluid exchange, studies of the blood, roentgenographic examination, and cystoscopy.

The cardinal sign of severe renal trauma is hematuria. It usually occurs shortly after the

accident but may not make its appearance until several hours later. The absence of hematuria when other signs of renal trauma are present suggests either occlusion of the ureter or complete laceration of it, as in a case reported by Connell. Ureteral colic usually does not appear for 24 hours. If hemorrhage is considerable, the bleeding may be followed by dysuria and urinary retention from intravesical accumulation of clotted blood. Bailey found acute retention of urine in 8 per cent of patients while oliguria was common after moderately severe injury of the kidney; anuria was rare.

The presence of a mass in the loin, superficial ecchymosis in the flank, tenderness, non-shifting dullness on percussion lateral to the rectus muscle, and unilateral abdominal muscular spasm are important physical signs of renal injury. The differentiation from injury of the liver or spleen is at times difficult. When contusion of the liver or spleen occurs, there is local pain, tenderness, muscular rigidity, and maybe a palpable enlargement of the organ. When rupture of either organ is produced, the predominating signs are those of hemorrhage into the peritoneal cavity, namely rapid pulse, pallor, low blood pressure, abdominal pain and tenderness, shifting dullness on percussion, possibly a fluid wave, diffuse abdominal



Fig. 5 Specimen of the kidney, Case 7 that was ruptured 30 years before nephrectomy as performed on account of subsequent calculous formation and infection.

rigidity and a high leucocyte count. The liver may be injured at the same time as the right kidney and likewise the spleen may be damaged when the left kidney is traumatized. Jaundice and bile-stained urine when they appear should point at once to a complicating hepatic injury. One of our patients, Case 20 exhibited evidence of simultaneous trauma to the liver and right

kidney. He had bile in the urine but showed no evidence of jaundice. Bailey reported the cases of 3 patients having rupture of the spleen and 2 of rupture of the liver. In all 4 cases there was an accompanying renal injury which was comparatively inconsequential. Despard operated upon 2 patients having a ruptured spleen and found rupture of the left kidney with a retroperitoneal hematoma as well. One patient who also had clinical signs of renal trauma, has been operated upon in this hospital for rupture of the spleen. At operation the splenic pedicle was found to have been torn across by the injury; splenectomy was performed. Despite repeated transfusions the patient died 8 hours after operation. Unfortunately postmortem investigation of the renal condition could not be carried out.

Following injury sufficient to cause a complete rupture of the kidney, the patient is usually in state of shock. Extra suction of blood into the renal fossa and concomitant hemorrhage into the renal pelvis and ureter occurs. While the patient is recovering from shock, observation is directed toward his general condition; the amount of hematuria, ureteral colic pain in the flank, abdominal distention, tenderness, and appearance of a mass in the flank. A roentgenogram of the abdomen may show a widening or obliteration of the iliopsoas muscle shadow, enlargement or loss of the renal shadow and a compensatory scoliosis.

There is immediate inhibition of function of the ruptured kidney which may be partial or complete. The degree of inhibition is roughly proportional to the severity of the trauma to the kidney. By means of intravenous urography one



Fig. 6. Retrograde pyelogram showing the anomalous renal pelvis of congenitally solitary kidney after injury. A slight extra suction into the lower pole is barely visible.

may ascertain something of the function of the kidney. The optimal time for intravenous urography must be determined for each patient. However, in general, urograms are more likely to be satisfactory after 12 to 24 hours delay. Detail is often obscured by gaseous distention of the intestine. Furthermore, the transitory inhibition of renal function may prevent an excretion adequate enough to demonstrate the anatomical defect. Wood has described 25 cases of renal trauma in all of which satisfactory urograms of the uninjured kidney were obtained, but in 13 instances there was insufficient excretion from the injured kidney.

Cystoscopic examination with ureteral catheterization yields additional information with reference to hemorrhage, vesical or ureteral obstruction, and function of each kidney separately. However, cystoscopic examination is sometimes impractical because the discomfort resulting from the injury makes co-operation difficult. When retrograde pyelography is necessary, the danger of causing further hemorrhage may be minimized by slow, careful injection of the opaque fluid.

If urinary excretion continues after complete rupture of the kidney, extravasation of urine and blood into the perirenal tissues occurs by way of the rent in the pelvis and parenchyma, thus forming a gradually enlarging mass. There is an accompanying fever and leucocytosis caused by stasis of urine, hemorrhage, and infection. The latter results from the invasion of bacteria and the former is contributed to by ureteral obstruction with clotted blood. When the laceration of renal substance involves only the parenchyma and there is no communication with the renal pelvis, urinary extravasation does not occur. Hematuria is present and there may be a palpable tender mass in the loin with subcutaneous ecchymosis that extends from above the costal margin posteriorly down to the iliac crest. Also, on account of the extrarenal hemorrhage there may be a retroperitoneal extravasation of blood that extends down along the course of the spermatic vessels to appear in the inguinal region and scrotum (Bugbee).

Contusion of the kidney without rupture of the capsule or pelvis is the simplest type of injury and may cause only mild symptoms. There are usually local symptoms of pain and tenderness in the flank without a palpable mass. Hematuria may be the only diagnostic sign of contusion, and in cases in this category it is usually transitory, and at times the urine contains only enough blood to color it slightly. Rarely there is only microscopic evidence of hematuria. When trauma has

been relatively insignificant it is especially important to search for some underlying renal lesion such as a congenital anomaly, hydronephrosis, tuberculosis, calculus, neoplasm, hemangioma, or nephritis.

TREATMENT

The early treatment of the patient suffering from an injury of the kidney is primarily directed toward combatting shock. The necessary urological and roentgenographic examination should be carried out after this condition has been relieved. Catheterization and irrigation of the bladder may be necessary to relieve urinary retention. Fluids should be forced, but sudden increases in blood pressure by parenteral administration of fluids must be avoided. Complete rest with the aid of sedatives is a most important element in early treatment. Therapy continues to be conservative under careful observation unless definite indication for operation is found. The indications in general for operation are persistent hemorrhage and extrarenal urinary extravasation. Exploration should be performed only after an investigation sufficient to establish a diagnosis. Knowledge of the condition of the other kidney should be had always before operation is performed. Operation accomplishes the control of hemorrhage and drainage. The former may be obtained either by suture of the renal parenchyma, tamponade with muscle, heminephrectomy, or nephrectomy. The difficult decision at operation is whether or not to remove the kidney. This should be determined by the degree of injury, infarction, infection, and the condition of the patient. Secondary nephrectomy was necessary in one of our cases on account of infection.

We have treated 27 patients having an injury of the kidney. Seven of these had a complete rupture of the organ. Nephrectomy was necessary for 4 of these and simple drainage was sufficient in the 3 others. Twenty patients who had contusion or partial rupture of the kidney recovered under conservative treatment only.

CASE 1. A man, aged 19 years, was admitted to the hospital 20 minutes after an automobile collision. He complained of pain in the right side of the chest and right flank. The voided urine was bloody. There was marked pallor of the face, the extremities were cold, and the pulse weak and rapid. There was tenderness over the lower six ribs in the right axillary line. The abdomen was soft, but a perceptible fullness and extreme tenderness were present in the right loin.

The patient was placed in Trendelenburg position and treated for shock. The pulse and blood pressure became stabilized at 100 per minute and 80/55 respectively. Roentgenographic examination of the abdomen showed widening of the right psoas shadow, and that of the chest

showed four fractured ribs. On the next day there was muscle spasm and tenderness in the right flank but no mass was palpable. On the third day urinary retention developed and the bladder was found to be filled with blood clots. Hematuria gradually diminished and the patient was able to urinate without difficulty but on the eighth day there was return of dysuria and hematuria which rapidly progressed to complete retention of urine. The bladder was again emptied by catheterization and irrigation. A large amount of blood clot was again obtained. He was again treated conservatively and hematuria subsided in 48 hours. During the first week the red blood cell count decreased from 4,000,000 to 2,500,000 per cubic millimeter and the hemoglobin from 70 per cent to 45 per cent. Intravenous urograms made on the sixth day showed no excretion of opaque substance from the right kidney and no abnormality of the left kidney (Fig. 1). The patient was kept in complete rest and showed definite improvement during the next 5 days, but on the fourteenth day he suddenly became weak and again began to pass very bloody urine. Nephrectomy was performed. The perirenal fat was edematous and contained encapsulated blood clot. Necrotic fat was adherent to the kidney. There was no urine or pus in the flank. The kidney itself showed bluish red discoloration and was swollen. The renal pelvis and ureter felt thickened and appeared edematous. A blood transfusion of 500 cubic centimeters was given. The postoperative course was uneventful.

Pathological report. The external surface of the upper half of the kidney was bright yellow in color with mottled areas of hemorrhage scattered throughout. In the anterior portion of the superior pole a star shaped opening extended through the parenchyma into the upper calyx. The section of the upper half of the kidney showed an indistinct demarcation between medulla and cortex. In the lower half of the kidney the demarcation between medulla and cortex was essentially normal (Fig. 2).

Microscopic examination. In some areas there was complete infarction extending from capsule to medulla. Along the periphery of the infarcts there was moderate congestion and hyperemia of the parenchyma. Considerable fibroblastic proliferation was present and exudation was slight. In some regions the renal tissue was fragmented and separated by organized hemorrhage. The parenchyma which was uninvolved by hemorrhage or infarction showed no variation from the normal. A section of perirenal fat showed extensive hemorrhage and fibroblastic proliferation. The veins were intensely engorged and in many instances contained deposits of fibrin and organizing thrombi, but the arteries were all preserved.

Diagnosis. Rupture of kidney multiple infarctions of kidney due to multiple thrombooses of renal vessels.

When a complete rupture of the kidney occurs there is usually urinary extravasation into the flank. The laceration extended through the renal cortex into the upper calyx in this patient. Hemorrhage into the perirenal tissues was not great and little evidence of urinary extravasation was found at operation 2 weeks later. This may be accounted for by presuming unilateral temporary cessation of renal function and plugging of the cortical rupture with blood clot. Hence no increase of fullness in the flank occurred after the first 24 hours following injury. This is further indicated by the fact that intravenous urograms made 6 days after the injury showed no excretion

from this kidney. The final pathological picture of multiple infarctions furnishes an adequate explanation for the impaired function. The recurrent hemorrhage, which was manifested by hematuria and vesical retention of urine due to clotted blood, occurred from the point of rupture in the upper calyx.

In retrospect, conservative treatment was indicated in this case until the eighth hospital day when the second severe hemorrhage occurred. Operation was postponed because of the quick response to conservative measures, the apparent cessation of bleeding with simultaneous improvement in the general condition of the patient, and because signs of local tenderness and mass in the flank were lacking. However the fact that third hemorrhage 6 days later necessitated an emergency operation and blood transfusion shows us that surgical intervention would have been justifiable at the time of the first relapse almost 1 week before. This is an example of the difficulties in treatment of patients having rupture of the kidney and intrapelvic hemorrhage without extrarenal urinary extravasation. Had the latter condition been present, decision in favor of early operation would have been made. It was this type of case that caused Connell, as long ago as 1900 to advocate early operation rather than expectant treatment, in all instances of rupture of the kidney. We do not subscribe to such radical attitude, but do grant that prolonged conservative treatment in the presence of hemorrhage may be dangerous.

Case. A laborer aged 30 years, was admitted to the hospital on account of pain in the left flank and blood in the urine. He had fallen 150 feet before and struck his left side. There was slight pain in the side at the time but he continued to work. The next day he began to suffer with cramp-like pains radiating from the left flank to the groin and umbilicus. At midnight the pain became intense and vomiting began. Then, for the first time, the urine was bloody. After rest in bed for 24 hours all pain and hematuria disappeared. Roentgenograms of the chest showed two fractured ribs. The patient was advised of the necessity of exploration of the left kidney. Operation was refused but 1 week later gross hematuria with passage of small blood clots recurred. Pain in the left side also returned and he entered this hospital. On examination there was swelling of the entire left side of the abdomen and tenderness in the left flank extended down to the anterior superior spine of the ilium. There was dullness on percussion from the flank to the umbilicus. At cystoscopic examination the bladder was found to be normal except for injection of the trigone. Urine from the right kidney was normal and from the left was bloody. A left retrograde pyelogram (Fig. 3) showed extravasation of the iodine solution into the kidney substance from the middle and inferior calyces.

At exploration the lower pole of the left kidney was found to be surrounded by and attached anteriorly to the retroperitoneum and extending several inches along

the ureter. When the sac was opened about 300 cubic centimeters of bloody urine and clot were evacuated. The laceration of the lower pole was practically healed. The renal fossa was thoroughly irrigated and drained. The kidney was not mobilized. The patient was discharged well on the thirty-fourth postoperative day.

This case demonstrates the rapidity with which symptoms may subside after a complete rupture of the kidney. Resumption of activity caused a recurrence of hematuria and an exacerbation of abdominal symptoms which caused him to seek further medical aid. The thickened fibrous sac was formed by the false renal capsule. Its attachment to, and encroachment upon, the peritoneum shows concretely how intraperitoneal signs and symptoms may be produced after injury of the kidney. It is remarkable that infection had not taken place in this large urinary extravasation, which was not drained until a month after injury.

CASE 3. A 15 year old boy fell 7 feet from a roof striking his left flank across the edge of a board. He experienced severe pain in the left side and voided bloody urine a few minutes later. The urine continued to be bloody for 48 hours and was coffee colored for 4 days longer. He vomited several times daily and continued to suffer from pain in the left side. He was sent to the hospital 1 week after injury.

The abdomen was held rigid and a large tender fluctuant mass filled the left flank. The urine examination was essentially negative. Phenolsulphonphthalein excretion was 80 per cent in 2 hours. Blood urea nitrogen measured 17 milligrams per cent. At operation the next day the renal fossa was found to contain 1000 cubic centimeters of odorless, amber colored urine. The lower pole of the kidney was found to be severed from the rest of the organ and was necrotic. The upper half of the kidney was contused and hemorrhagic. Nephrectomy was performed and the renal fossa was drained. The patient's temperature fluctuated between 100 and 101 degrees F for 7 days. Thereafter recovery was rapid. The patient was well 2 years later.

Pathologic examination. The specimen was a kidney and a fragmented bit of renal tissue together weighing 115 grams. At one pole the renal substance was greatly roughened and necrotic. Just distal to the hilum there was a gap in the renal substance and the edges of this were extremely injected and necrotic. Upon section the uninjured pole of the kidney presented a reddish brown surface on which cortical and medullary markings were readily distinguished. At the other pole, however, there was considerable necrosis. The severed portion of renal tissue weighed 20 grams.

A microscopic section from the lower pole of the kidney showed tissue which was distinctly necrotic in appearance. There were many focal areas of round cell infiltration and a few polymorphonuclear leucocytes were seen. The perirenal fat showed hemorrhage and bands of fibrous tissue heavily infiltrated with eosinophils and polymorphonuclear leucocytes.

Diagnosis. Ruptured kidney with necrosis of lower pole.

CASE 4. A 48 year old carpenter fell a distance of 25 feet striking on his left side. There was immediate sharp pain in the left chest and abdomen. Six hours later he voided about a pint of bloody urine. Intermittent hematuria and pain radiating from the flank into the left lower quadrant of the abdomen persisted for 5 days. The patient exhibited

rapid breathing, flushed facies, and moderate emaciation. There was diminished resonance to percussion in the left axilla and below the angle of the scapula. The left flank presented a visible, tender fullness. There was muscle spasm over the left side of the abdomen and extreme costovertebral tenderness. The white blood cell count was 26,000 per cubic millimeter, and the urine contained pus cells and casts. The left kidney shadow was not visible in a plain film of the abdomen. Two hour excretion of phenolsulphonphthalein was 70 per cent. Three days after admission to the hospital, exploration was performed. Purulent urine containing clotted blood was drained from the left renal fossa. There was a rupture through the cortex of the kidney, but bleeding had ceased. The wound was drained through the posterior angle and the kidney was not mobilized. The postoperative course was complicated by a septic temperature, persistent pyuria, and bronchopneumonia. The culture of the urine yielded a growth of *Staphylococcus aureus*. The patient developed an infected urinary sinus and 4 weeks later nephrectomy was performed. He was well upon discharge 4 weeks later.

Pathological report. The kidney was pale yellow in color. There was a red irregular contracted area 3 by 2½ centimeters extending into the hilum. On section the cortex was indefinite and pale. A large contracted scar extended through the cortex and one section was composed of white scar tissue. There were numerous groups of small hemorrhages through the cortex and multiple small abscesses.

The microscope showed that the cortex of the kidney contained numerous small abscesses. The tubules contained leucocytes, granular material, and round hyaline particles. Section through the scar showed an area of granulation consisting largely of new formed fibrous tissue, phagocytic cells and small mononuclears.

Diagnosis. Rupture of the kidney. Multiple abscesses of kidney.

This patient's complicated hospital course may be attributed to urinary extravasation which, not being drained early, became infected. Nephrectomy was not performed at the first operation because of the presence of the perirenal infection and a lack of knowledge regarding the uninjured kidney. Intravenous urography, which was not available at that time, would have been helpful since the patient was thought to be too ill to undergo cystoscopy before the first operation. The persistent infection resulted in multiple cortical abscesses and necessitated a secondary operation for removal of the organ.

CASE 5. A 39 year old woman was admitted to the hospital complaining of pain in the right side of 16 hours' duration following a fall downstairs. She suffered immediate severe pain in the right flank followed by nausea and vomiting. She was unable to void and when catheterized the urine was bloody. The patient was an obese woman in great pain. There was tenderness and muscle spasm in the right loin. The urine was bloody, the white blood cell count was 23,600, the non protein nitrogen of the blood was 36 milligrams per cent. Intravenous urograms 48 hours later showed the opaque medium in both renal pelvis in 5 minutes. The right renal pelvis was slightly enlarged and distorted, there was an extravasation from the pelvis into the renal substance.

The patient continued to have pain in the right flank and a mass became palpable there 48 hours after injury.

TABLE I.—ANALYSIS OF 20 CASES

Case No.	Sex, Age	Treatment	Post	Physical examination	Duration	Condition and roentgenographic examination	Diagnosis	Treatment	Miscellaneous	Result and follow-up examination
8	M 26	Pull on leg	Left flank	1 flank tenderness	days	Perforation of small intestine in Uterus—lower calyx normal	Contusion of kidney	Rest in bed—6 days		Pyelogram normal 1 year later
9	F 35	Confining	Left flank and right side	Spasms and back tenderness. Temp 100°—4 days	days	Blood clotting from 1st urine	Partial rupture of kidney	Rest in bed, 6 days, frequent use of ice bag	Unable to read for 4 hours	Recovery
10	M 34	Aspirate	Back and abdomen	Painless, muscle spasms, tenderness, rigidity later in right flank	hours and increased rigidity later in days	Normal renal shadow, no pyelogram	Contusion of kidney	Rest in bed—6 days	Severe renal colic with pressure of clasp	Recovery
11	M	Pull from belt	Left chest, flank, abdomen	Painless, tenderness in left flank 3 days post-injury—4 days	days	Uterus normal	Contusion of kidney	Rest in bed—10 days	Extensive ecchymosis in loin appeared in 4 hours	Recovery
12	M	Confining	Right flank	Mild rigidity, tenderness in right flank	5 days	Uterus normal	Contusion of kidney	Rest in bed—6 days	Ecchymosis in loin	Recovery
13	M 25	Confining	Left chest and abdomen	Shock, confusion, rigidity in chest, tenderness in abdomen, rigidity in left flank	days	Unable to read, catheterization failed, bloody urine and clots	Contusion of kidney and lung	Rest in bed—6 weeks, fluoroscopic	Fluoroscopic examination normal	Recovery
14	M 26	Kidney pelvis, pharyngeal fistula	Lower left flank	11 P. abd. pain, tenderness and rigidity in left flank	days, many clots passed	Obstruction of left renal calculus	Contusion of kidney	Rest in bed—6 weeks	Major and vesical prostatic pressure dist. normal	Recovery
15	M 26	3rd day, by order of physician	Left flank	Tenderness and rigidity in left flank. Temp 100°—4 days	6 days	Left renal shadow enlarged. From abdominal trauma contusion to left Uterus, renal pelvis, left kidney	Partial rupture of kidney	Rest in bed—6 weeks	Onset of hours	Uterus and muscle later show normal outline of both kidneys and pelvis
16	F	Aspirate	Left flank and back	Tenderness and rigidity in right flank and thorax	days	No pyelogram	Contusion of kidney	Rest in bed—6 days	2 Contour examination, no abnormal conditions from pelvis	Uterus, no gross lesion later than normal, no pyelogram of left renal pelvis
17	M 25	3rd day, by order of physician	Left chest only	None	Continued for 15 days, no abnormal conditions	Left renal shadow enlarged, pyelogram normal, renal pelvis	Contusion of kidney	Rest in bed—6 days		no gross lesion later than normal pelvis

TABLE I—ANALYSIS OF 20 CASES—Continued

Case No.	Sex Age	Trauma	Pain	Physical examination	Hematuria	Urologic and roentgenographic examination	Diagnosis	Treatment	Miscellaneous	Result and follow up examination
18	M 15	Fall from step-ladder	Right side loin and abdomen	Tenderness fullness and muscle spasm in left flank	3 days	Blood coming from right ureter. No left kidney demonstrable by cystoscopy or intravenous pyelography. See Fig. 6	Contusion of right kidney	Rest in bed—7 days	Right kidney palpable after muscle spasm subsided	2 years later patient quite well and kidney not palpable. Cystoscopy 4 years later showed no resultant effects of trauma
19	M 14	Fall from step-ladder	Left side of abdomen with vomiting	Tenderness in left flank	8 days	Renal shadows normal I SP 80 per cent	Contusion of kidney	Rest in bed—16 days		Recovery
20	M 50	Fall against earthen jar	Right side of chest and abdomen	Spine concave to right. Abdominal and flank tenderness and spasm	Microscopic only. Also urine bile stained for several days later	PSP 60 per cent	Contusion of right kidney and liver	Rest in bed—12 days. Chest strapped	Temp 101° for 48 hours. No jaundice visible	Recovery
21	M 37	Fall against board	Right side of abdomen and loin	Muscle spasm tenderness right flank and abdomen	3 days. Urine negative after 7 days	Film showed no abnormality	Contusion of kidney	Rest in bed—8 days	No further renal complications	Recovery—Died of lymphoma 9 years later
22	M 14	Coasting accident	Left flank	Temp 101° B p 70/55. Flank tenderness	3 days	Urine negative after 3 days	Contusion of kidney	Rest in bed—21 days	Complication—Bronchopneumonia	Recovery
23	M 45	Fall over bench	Right flank and abdomen	Acutely tender in flank and right side of abdomen	2 days	Urine 12-12 erythrocytes only after 2 days. Urograms normal	Contusion of kidney	Rest in bed—5 days in hospital and 7 at home	Abdominal distention, nausea, and vomiting 4 days	Recovery
24	M 13	Sliding accident	Right chest and flank	Tenderness and muscle spasm in abdomen and flank	2 days	PSP 95 per cent	Contusion of kidney	Rest in bed—5 days in hospital and 7 at home	Nausea and vomiting for 24 hours	Recovery. 9 months later physical and urine examination negative
25	M 31	Fall from horse	3 days later right flank and abdominal pain	Right flank and abdominal tenderness	Microscopic examination many r.b.c. and w.b.c.	PSP 90 per cent. Culture of urine staphylococcus. Pyelogram normal	Contusion of kidney	Rest in bed—7 days		Recovery
6	M 15	Football injury	Right flank	Tenderness in right flank	3 days	Right hydronephrosis due to aberrant vessel previously operated upon	Contusion of hydronephrotic kidney	Rest in bed—7 days		Urograms 4 months later showed no change in contour as result of injury
7	M 4	Fall from window	Back and chest and left loin	Contusion of chest. Tenderness in flank with muscle spasm	20 erythrocytes for 48 hours	Oliguria 24 hours. PSP 90 per cent. Urograms normal	Contusion of kidney	Rest in bed—21 days	Fracture transverse process of lumbar vertebrae II and III	Recovery

On the third day operation was performed under spinal anesthesia. There was hemorrhage in the tissues beneath the external oblique fascia. The renal fossa as found to contain much clotted blood. There was transverse rupture of the lower pole of the kidney. The kidney itself as not mobilized but the renal fossa as drained. Postoperatively course was uneventful.

Diagnosis. Rupture of kidney

Nephrectomy was not performed on this patient because the rupture was not severe and there was no complicating infection present. Relatively early operation with adequate drainage was an important factor in her satisfactory recovery. Three years after injury intravenous urograms show prompt excretion from both kidneys. There is a dilatation of the inferior calyx of the right kidney in the previous site of rupture (Fig. 4). The films demonstrate concretely the remarkable recuperative powers of the kidney.

CASE 6. A white woman, aged 35 years, came to the hospital complaining of pain in the left shoulder, chest, and flank, shortly after being struck by an automobile. In the left upper quadrant of the abdomen there was slight muscle spasm and tenderness to light palpation. Non-shifting dullness on percussion was noted in the left side of the abdomen. The whole left flank was very tender on pressure, both anteriorly and posteriorly. A rupture of the spleen as considered at first, but there was no evidence of shock, severe hemorrhage, or fluid in the abdomen. The first voided urine as bloody. After 4 hours the urine exhibited only smoky red color. The white blood cell count was 5,000 on admission and 20,000 the next morning. Falls in the flank and pain increased steadily for 72 hours. On account of the rising leucocyte count, chanc pulse, persistent pain, and ever-increasing mass in the flank, exploration as performed. The peritoneal tissues are found to be infiltrated by pale bloody fluid. A ragged, yellow cleft like depression was palpated on the posterior aspect of the kidney. T. rubber tissue drains are placed in the renal fossa to provide for drainage. Postoperative convalescence as uneventful and the drainage of urine ceased on the fourteenth postoperative day. The patient was discharged all on the fifteenth day. She as in good health when last heard from two years after operation.

Diagnosis. Rupture of kidney

This patient was treated expectantly until definite clinical evidence of urinary extravasation was present. Operation was performed before an invasion of bacteria had taken place and it was possible to save the kidney by drainage.

CASE 7. A woman, aged 3 years, was admitted to the hospital with the complaints of weakness, weight loss and pain in the back for 3 years. Also, chills, fever, nausea, vomiting, and diarrhea lasting 3 to 4 days had occurred intermittently. Urinary frequency, dysuria, and the passage of cloudy urine had been noticed for several months. At the age of 3 years the patient fell down stairs striking the left side on the edge of step. Following this for weeks she had been extremely ill and there occurred profuse hematuria. Her attending physician made the diagnosis of ruptured kidney. After weeks, recovery as uneventful.

There as some tenderness on deep palpation below the left costal border. At cystoscopic examination the ureters

and bladder were normal. A plain film of the abdomen showed two irregular shadows opposite the transverse process of the second lumbar vertebra on the left. The right pyelogram was normal but the left kidney pelvis as incompletely outlined and the opaque fluid covered the shadows seen in the plain film. Examination of the blood showed changes characteristic of pernicious anemia.

A pre-operatively diagnosis of calculus pyonephrosis and pernicious anemia as made. At operation the kidney as found to be adherent in the region of its pelvis and lower pole to dense surrounding tissue. A mass, 4 by 3 centimeters, as attached to the lower pole of the kidney and was intimately adherent both to this and to the ureter. Nephrectomy as performed removing at the same time the small mass and the portion of adherent ureter. She was discharged on the twenty-fourth day after operation in an improved condition.

Pathological report. The specimen was kidney measuring 8 centimeters in length and 4 1/2 centimeters in width to which was attached at its lower pole additional kidney tissue measuring 4 by 3 centimeters (Fig. 7). The two weighed 80 grams together. The kidney had tough and red capsule which was stripped with difficulty leaving ragged surface. The whole kidney as yellow and moderately firm in consistency. The structural details were obscured. A calculus measuring by 1/2 centimeters occupied the pelvis. The smaller piece of kidney tissue presented the same shape, color and consistency except that its substance was largely taken up by the pelvis, only narrow margin of cortex being left at some places.

Diagnosis. Injury to kidney with repair. Renal calculus. Pernicious anemia.

This is an unusual case which has not been duplicated in the literature. This patient had undergone a severe rupture of the kidney which, however failed to tear the pelvis and ureter. Subsequently a calculus was formed in the kidney which was discovered along with the traumatic malformation many years later. Also, during this time the patient developed pernicious anemia, presumably a pure coincidence.

A summary of the records of twenty patients having contusion or partial rupture of the kidney is shown in Table I.

ANALYSIS OF 27 CASES OF INJURY TO KIDNEY

This series is made up of 27 instances of injury to the kidney of varying degrees of severity. In all cases the trauma occurred directly over the region of the kidney. The left kidney was injured seventeen times and the right ten times. Falls from varying heights occurred in 15 instances, and in 10 of these the patients fell upon some sort of edged object which was driven directly against the flank or lower thorax. Four of the remaining cases were the result of traffic accidents and 7 resulted from injuries sustained as a consequence of mishaps in football games or coasting. The remaining instance followed a fall from home. It is to be seen clearly from a consideration of these various forms of trauma that in order to involve the kidney the injury must be of consider-

able severity as well as located in the loin. This may be of some importance in making the diagnosis in certain questionable cases.

The cardinal sign of rupture of the kidney in a person who has sustained an accident of this character is hematuria. In 24 of our 27 patients there was hematuria, sufficient enough to be detected by inspection, and in the 3 other instances blood was demonstrated in the urine microscopically.

Diffuse abdominal pain, accompanied by considerable muscle spasm on the side of the injury, was present in 13 of the cases. Somewhat less often (6 times) subcutaneous ecchymosis in the flank and side of the abdomen was found. Nausea and vomiting were early symptoms on seven occasions. This was especially frequent when large clots were passed through the ureter. The passage of such blood clots may be of considerable clinical significance also, since 2 of our patients developed urinary retention from obstruction by the clotted blood.

As a complication of the injury to the kidney, the thorax was not infrequently involved. Respiratory pain resulting from thoracic injuries was present in 14 of the cases and in 5 of these there were demonstrable fractures of the ribs. Six of the patients had such pulmonary complications as atelectasis and bronchopneumonia. However, hemothorax of sufficient degree to necessitate thoracentesis resulted only once. Fractures of the lumbar vertebrae were present only in 1 patient.

The end-results in all of these cases have proved the great value of conservative treatment for patients who have had renal trauma. Careful study with prolonged rest may often avoid operation. Furthermore, it is essential that sufficient investigation be carried out to establish the diagnosis with accuracy before operation is undertaken. This is especially important if the localizing signs are not clear, because the lumbar approach to the kidney does not as easily permit the exploration of various viscera as an abdominal incision does. The indications for immediate operation are persistent hemorrhage, urinary extravasation or infection. While many of our patients are brought directly to the hospital after injury, in some instances they did not appear for as long as 75 days. In one instance (Case 2) the patient appeared 25 days after the injury and the evacuation of a large extrarenal sac of blood and urine resulted in complete recovery. When the kidney is exposed at operation, it is often a problem whether to perform nephrectomy or simple drainage. In three of our patients, simple drain-

age was instituted, and in 4 instances nephrectomy was performed. In all of these cases a complete rupture of the kidney had taken place. The indication for operation in Case 1 was protracted severe hemorrhage into the urinary tract. In Cases 2 to 6 inclusive the operative indications were extrarenal hemorrhage and urinary extravasation. Operation in Case 7 was necessitated for renal calculi 20 years after the injury. In deciding which is preferable, we wish to call attention again to the remarkable recuperative powers of the kidney, once obstruction and urinary extravasation have been relieved.

In the entire series of 27 cases, there was no mortality. This we feel offers justification of a conservative attitude in treating these patients. In the case referred to previously in which there was a question of renal trauma in a patient with rupture of the spleen, death occurred, but this case could not be included in our series since there was no clinical or postmortem opportunity to verify the presence of the renal damage.

After recovery from the immediate injury, it is important to remember that certain patients may be expected to show various degrees of renal impairment. One of our patients (Case 7) was found to have an almost complete division of the kidney and a renal calculus 20 years after the injury. In another an abnormal pyelogram suggested the presence of a papilloma of the renal pelvis (Case 16). In still a third (Case 17) a renal calculus, which may have formed on a nidus of material resulting from the renal injury, was discovered 10 years later.

The presence of lesions of certain types in the kidney may make it more vulnerable. One of our patients, Case 26, had a hydronephrosis. This large mass was doubtless more susceptible to trauma than would a normal kidney have been. In another of our patients, Case 18, there was a solitary kidney. In this instance the question of treatment is indeed acute and resembles the consideration which must govern the attack on calculi in a solitary kidney. It is hardly necessary to say that renal trauma is no excuse for not investigating the presence or absence of a kidney on the other side before operation is considered. Turton and Williamson have described an instance of traumatic rupture of a congenital solitary kidney. A school boy aged 12 years fell a distance of 5 feet striking on his left side. He complained of pain in the loin and the voided urine was bloody. At operation it was learned by exploration that the right kidney was absent, the ruptured left kidney was treated by drainage and recovery was uneventful. They summarized

4 other cases from the literature (namely those of Melchior Speer Brattstrom, and Thompson) of rupture of the congenital solitary kidney. In each of these cases nephrectomy was performed and the absence of the other kidney discovered at autopsy. Bailey has cited further instances in which the kidney was the site of various other lesions prior to injury. One of his patients had multiple calculi, 4 had hydronephrosis, and in 1 instance there were cysts of the kidney. These cases further emphasize the necessity for thorough investigation before operation is undertaken in patients suffering from renal trauma.

SUMMARY

Twenty-seven patients have been presented who suffered from various kinds of renal trauma. In each instance injury was caused by direct application of force over the kidney.

Hematuria is the cardinal sign of injury to the kidney in a patient who has recently sustained an accident.

Conservative treatment yields good results. There is a tendency for spontaneous improvement owing to the processes of natural repair. The absolute indications for operation are persistent hemorrhage, urinary extravasation or renal infection. There was no mortality in our series.

Because of the possibility that congenital or acquired lesions of the kidney may antedate the trauma, thorough studies of the uninjured kidney, as well as the traumatized organ must precede operation.

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GAS IN THE BOWELS

Observations and Experiments in Man

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WHILE recent investigations on intestinal gas are concerned chiefly with its significance in mechanical and adynamic ileus (7, 8, 9, 14, 19, 20), the following study has its origin in the observation that on roentgenograms gas in the bowels is as often present when least wanted as it is absent when expected. For instance, in abdominal colic when it is important to see clearly roentgenographic details such as small concretions, very large quantities of gas are often superimposed consistently upon the viscera, whereas in patients with flatulence or eructations the amount of gas visible is usually negligible rather than increased (1). In roentgenological practice, gas is of interest mainly in as far as it can be eliminated. For this purpose, some examiners prescribe a special diet, often combined with medication of diastatic enzymes, and followed by catharsis, enemas, and injection of one of the postpituitary or physostigmin preparations. Others hold that the best way of preventing gas formation consists in avoiding any of these measures. During attempts at clarifying this discrepancy, it was found that the question pertains to a general physiological problem which has many practical aspects. This report is the outcome of studies and experiments scattered over a period of 9 years and involving slightly over 400 observations in man.

ROENTGENOLOGICAL OBSERVATIONS ON GASEOUS DISTENTION

If one examines patients who had received a cathartic and an enema one often finds large amounts of gas accumulated in the colon. Sometimes repetition of the enema results in elimination of most of the gas but equally often a second enema seems to make the gaseous distention grow worse. Hence it is commonly suspected that instead of being eliminated, gas may be introduced by enemas in the form of atmospheric air. But the author found it practically impossible to introduce air with an opaque enema for any large air bubble is locked either in the tube or in the upper rectum preventing further inflow.

Small amounts of gas may perhaps get into the colon, but they are not large enough to account for the quantities of gas often seen on roentgenograms after cleansing enemas, these quantities corresponding to about 600 to 900 cubic centimeters of air inflated per rectum. Insufflation of more than 400 cubic centimeters of air usually causes considerable distress, whereas the patients with the spontaneous distention here discussed are not commonly conscious of the presence of gas. This point proved to be significant in the further course of the study.

Giving food devoid of fermentable material, together with preparations containing diastatic enzymes and hemicelluloses, does not always help to prevent gas formation. In 1930, R. Becker and the author made the following unpublished experiments. Of 12 patients with renal calculi, in whom very large amounts of gas were present on roentgenograms, 6 were given normal food and no medication, the other 6 received a diet practically free of cellulose together with an enzymatic preparation which had been recommended as "ideal" for preventing gas formation. Roentgenograms taken on the fourth day showed the intestines to be almost free of gas in 3 persons of the second, or treated, group. But the amounts of gas visible were equally small in 4 patients of the first, or untreated, group. Because of the assumption that failures in the treated group might have been due to insufficient dissolution of the coating of the drug in the intestinal tract, the experiments were repeated with samples of the coating containing barium sulphate powder instead of the active substances. In 2 of 6 patients, the undigested drages were seen as rounded opaque bodies during 48 hours on roentgenograms and were recovered in the stools afterward. But even in these 2 patients, as in all the others in the series, the intestines were almost free of gas on the third day. This result was not enlightening. The verified failure of the drug to act did not explain the negative results of the first series as it evidently did not account for the positive results of the second one. The inference that intestinal fermentation is not responsible for the gaseous distention here under discussion was not in accord with accepted teaching which at that

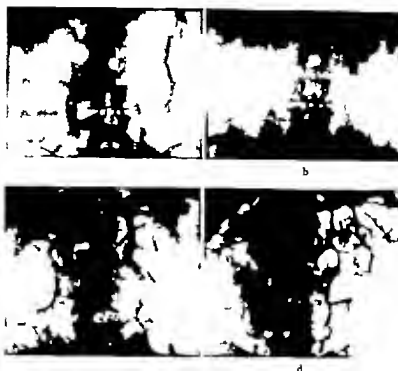


Fig. 1. a, Intestines full of gas during renal colic. b, Without any treatment or diet, the digestive tract is almost free of gas 3 days later, when pain subsided. c, Another case of gaseous distention during renal colic. For the 3 subsequent days, the patient received a diet practically free of fermentable material, together with diastatic enzymes, an enema was given the night previous to, and 3 hours before, re-examination, and Voegtlin units of pepsin are injected subcutaneously 35 minutes before roentgenography; nevertheless, gas is still as abundant as before d, pain being still present.

time referred to fermentation as proved *in vitro* (17) as the cause of the largest part of the gas present in the bowels. Although recent analyses have shown that over 70 per cent of intestinal gas consists of atmospheric air (5, 20) daily experience proves that gas formation is very much increased by normal or abnormal fermentation.

To ascertain this point, 6 patients with pathologically increased intestinal fermentation, as shown by strongly positive fermentation tests (16) were examined simultaneously with healthy subjects, both receiving the same food and no medication. In the healthy subjects, gas was seen to accumulate gradually in the transverse colon and splenic flexure in the course of the day, a maximum being found in the late evening, and a minimum in the early morning. Very little gas was present in the small intestines, and none at all in the terminal ileum. In the patients with fermentation, gas was abundant in the terminal ileum, no matter whether symptoms

were present or absent at the time of the examination. This gas either formed large bubbles which occupied as much as the entire terminal loop of the ileum (Fig. 1) or it was thoroughly mixed with the opaque medium, thus giving the latter a foamy or frothy appearance. Gas was also definitely present in other small intestinal loops, as well as in the colon. But in none of the patients with fermentation were the amounts of gas larger than in the healthy subjects, nor as large as in gaseous distention on roentgenograms of the urinary tract. Since the experiment had been confined to instances of well marked fermentation, it was inferred that fermentation is not responsible for the gaseous distention discussed at the outset.

What happened, then, to the large volumes of gas which, as shown by an objective test, were formed in the patients with fermentation? Probably nothing else than what happens to the gas in healthy persons. The observation that as a rule much more gas is present in the evening than



FIG. 2. (a) Terminal loop of ileum filled with gas in a case of chronic indigestion. (b) Gas in terminal ileum slightly gravated with opium medication.

in the morning seems to indicate that influences of domestication are easily overcome during sleep. The autonomic system tactfully eliminates the gas while its bearer is least conscious of the accumulation. In order to keep comfortable, the person with increased fermentation has to get rid of the gas on other occasions as well. Incidentally, a similar need sometimes acts upon the stomach. The gas bubble of the stomach is fairly constant in size in health. When increased fermentation of starch, bicarbonate as powder or soda water, cold water, contraction expels the extra amount by belching, while after the gas bubble is actually swallowed on at the beginning of the

observation, but it resumes its normal size and configuration in the course of an hour. It may safely be concluded that in the human digestive tract amount of gas which exceed a certain tolerated volume are expelled, but do not cause distention provided the intestinal muscle is in normal condition. This inference will hardly be considered to add to my knowledge.

EXTENSIVE COLLECTION OF CASES OF DISTENTION BY GAS

It has become evident at this stage of the investigation that the contractility of the intestinal muscles plays an important part in the pro-

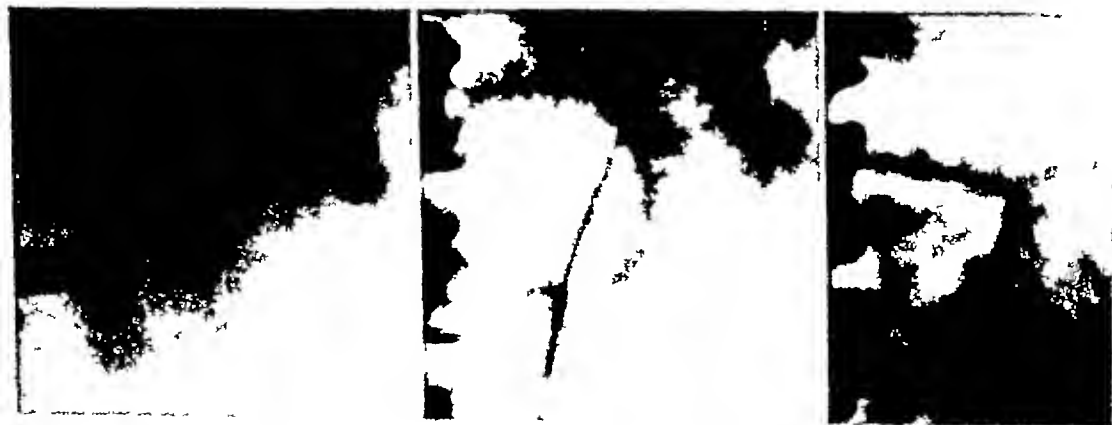


FIG. 3. (a) Terminal loop of ileum filled with gas in a case of chronic indigestion. (b) Gas in terminal ileum slightly gravated with opium medication. (c) Gas in terminal ileum slightly gravated with opium medication.



Fig. 4 a, Intestines overfilled with gas during retrograde pyelography b, The opaque enema shows the degree of colonic enlargement on this occasion. Forty-eight hours later repetition of the opaque enema revealed normal colon. A case of long-standing hydromephroses, *Bacillus coli* infection

duction of non-surgical gaseous distention for large amounts of gas do not normally remain in the bowels for a long time. The observation that excessively large quantities of gas may appear during retrograde pyelography when this procedure produces pain, led to a systematic study on the relations between pain and gaseous distention. In 82 instances of severe pain such as in the presence of fractures of the extremities and of the vertebral column, gonococcal arthritis, sciatica, lumbago, toothache, trigeminal neuralgia, herpes zoster, dislocations, no gaseous distention was observed. But in numerous cases of renal colic, in 8 patients with biliary colic and in 3 with duodenal ulcer, as well as in acute inflammation of the appendix or of the pelvic organs, the type of gaseous distention seen was identical with that found during retrograde pyelography. In 4 patients with urinary diseases gaseous distention developed during intravenous urography about 1 minute after injection of any of the dyes available with complete absence of pain or other symptoms. Accordingly pain is not in itself responsible for the appearance of gas in the bowels, but it would seem that in certain circumstances some abdominal diseases may cause gaseous distention even in temporary or permanent absence of pain. Pain and gaseous distention are then independent symptoms of the same disease.

Further analysis of the roentgenographic records showed that the intestines were often almost free of gas immediately before ureteral

catheterism but as soon as the catheter was inserted the stomach, small intestine, and colon were overfilled with gas (Fig. 3). In the small intestine, besides widening of their lumen the annular valvulae conniventes became distinctly visible (Fig. 3 c). In the dilated colon, haustration was scarce and shallow (Fig. 4). This was confirmed by opaque meal and opaque enema examinations in the course of which one renal pelvis was distended by injection through a catheter of Cameron's solution or by distention with oxygen (11). This procedure immediately caused the normal intestinal pattern to disappear; the lumen suddenly became wide, peristalsis ceased, and the valvulae emerged into the mucosal pattern simultaneously; the colon increased in width and length so considerably as to allow 4 liters of opaque enema to be instilled, while normally it did not hold more than 1.2 to 1.8 liters at maximum (Fig. 4). Widening and lengthening of the colon, scarce haustration, and prominence of the valvulae conniventes are signs typical of paralysis of the bowels, such as observed in paralytic ileus and in the dead organs. The fact that to 36 hours later the intestines resumed normal size and pattern, proves that the acute transient paralysis or atony was not caused by damage to the intestinal muscle but by some inhibitory reflex acting upon the intestinal walls, as in animals with experimental peritonitis (2).

The very large amounts of gas observed in these conditions could not possibly be due to any

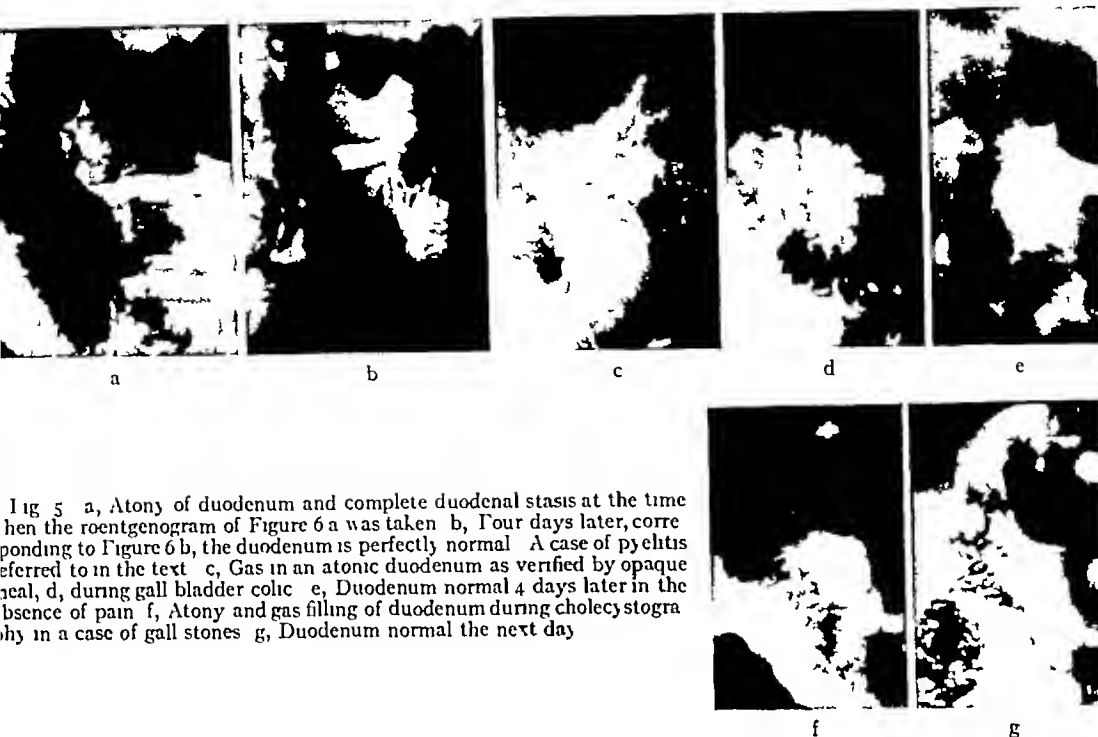


Fig 5 a, Atony of duodenum and complete duodenal stasis at the time when the roentgenogram of Figure 6 a was taken b, Four days later, corresponding to Figure 6 b, the duodenum is perfectly normal A case of pyelitis referred to in the text c, Gas in an atonic duodenum as verified by opaque meal, d, during gall bladder colic e, Duodenum normal 4 days later in the absence of pain f, Atony and gas filling of duodenum during cholecystography in a case of gall stones g, Duodenum normal the next day

abnormal fermentation, as the gas overhilled the entire digestive tract within a few minutes. The sudden relaxation of the intestines during atony caused the gas to fill the bowels merely passively. It is not likely that so large amounts of gas could be absorbed into the intestinal lumen from the blood stream during such a short time (5, 8). Hence one may assume that the small amounts of gas always present in the intestines expanded in the suddenly created relative vacuum, a mechanism to which no attention seems to have been paid hitherto.

The disappearance of intestinal atony within a day or two after renal colic or experimental irritation of the renal pelvis, explains the fact that in the roentgenological observations reported, gaseous distention subsided while the patients were simply kept at rest.

MECHANISMS OF REFLECTIVE GASEOUS DISTENTION

In patients with abdominal symptoms gaseous distention may fail to develop during retrograde or intravenous urography, but may appear during other diagnostic measures. In 6 cases of verified gall-bladder disease, gas appeared in the intestines 10 hours after oral ingestion of a cholecystographic dye, in 4 of them, it was the descending

duodenum which was most conspicuously widened (Fig 5, f). In 3 patients with appendicitis, the entire colon relaxed suddenly during palpation of the appendix during radioscapy and filled with gas within less than 2 seconds.

Two case histories out of many may serve to illustrate the mechanisms involved.

The first patient, a woman aged 30 years, was admitted because of uncontrollable nausea and vomiting of a few days' duration. There was some slight, dull, spontaneous pain in the right upper quadrant, but no tenderness. The stomach, small intestines, and colon were filled with gas (Fig 6, a). An opaque meal examination showed the dependent duodenum to be very wide and devoid of any peristaltic activity (Fig 5, a), the opaque medium remained inert in it for over 20 minutes, after which time the examination had to be discontinued because of the weakness of the patient. Four days later the symptoms had subsided during rest in bed, re-examination showed that both the gaseous distention and the duodenal stasis had disappeared (Figs 5 b and 6 b). But on intravenous urography, gas reappeared in the small intestines 7 minutes after injection of the dye (Fig 6 c). Further study revealed an infection of the right renal pelvis with streptococci and *Bacillus coli*. The infection was treated and the symptoms so far have not recurred.

Incidentally, this observation throws some light on mechanisms of duodenal stasis discussed recently (12). In a man 37 years old referred because of obscure abdominal colic, retrograde pyelography with 12 cubic centimeters of Cameron's solution did not elicit gaseous distention, but 12 hours after oral administration of a gall bladder dye the dependent duodenum filled with gas and the intestines



Fig. 6. A case of pyelitis referred to in text. *a*, Intestines tonic and filled with gas. *b*, Four days later in the absence of pain, the intestinal tract is shown to be almost

erect and filled with gas (Fig. 7). Three weeks later the gall stone localized was removed from the badly infected gall bladder.

These observations are examples to show that the inhibitory reflex responsible for intestinal atony and gaseous distention is elicited most easily and sometimes exclusively by stimulation of the diseased organ itself, but less commonly by that of a neighboring healthy viscus. Stimulation may be chiefly chemical, as in cholecystography and intravenous urography or chiefly mechanical, as in distention of the renal pelvis with Cameron's solution or oxygen. But clearly the diseased organ must be capable of responding to mechanical stimulation. Thus, in excessive degrees of hydronephrosis mechanical distention of the enlarged renal pelvis may fail to excite the reflex responsible for atony and gaseous distention (Fig. 9 *e* and *f*). On the other hand these signs are especially marked during the first acute stage of the diseases involved, when the affected viscus, not yet being accustomed to its morbid condition, as it were responds almost violently to the disease as well as to interferences. This occurs, for

instance, in the presence of concretions still very small. This variability of response accounts for the mischief that gas is abundant precisely when its presence interferes most thoroughly with the roentgenological examination.

RELATIONS BETWEEN GASEOUS DISTENTION AND ITS CLINICAL SYMPTOMS

While one main type of gaseous distention seems to be the result of acute intestinal atony the scarcity of gas in the stomach or intestines in cases of distention has still to be considered.

During an abdominal operation or immediately after it, the atonic intestines begin to fill with gas, as easily demonstrable on percussion. But for at least 20 hours, gas pains do not commonly appear (13). They set in after this time and are usually followed by the first sign of recovery passing of some gas. In a majority of patients the distress begins at night that is, according to the foregoing during the period at which the normal intestines also are wont to eliminate gas.

Another type of gas pains, the colica flatulenta of the older clinical literature occurs spontane-



Fig. 7. A case of gall bladder disease referred to in the text. *a*, Normal amount of gas in the intestines, not increasing during overfilling of left renal pelvis by retrograde

injection of 20 cubic centimeters of opaque dye. *b*, *c*, Intestines tonic and filled with gas during cholecystography.



Fig 8 a, Very large gas bubble in a healthy student not conscious of any symptoms b, In a man with uncontrollable belching due to severe gastritis, the gas bubble is conspicuously small

ously In the 6 cases observed by the author, the excruciating pain awakened the patients at night once or twice a year During this attack, the pulse is feeble, respiration is accelerated, there is marked pallor, and sometimes profuse perspiration The condition resembles most a renal colic, but there is neither tenderness, nor anuria, nor any other sign typical of urinary disease The 6 persons observed, 3 males and 3 females, were between 30 and 40 years old, all of them were high-strung, and 2 had gone through a nervous breakdown shortly before the onset of the colics In 3 cases, roentgenographic examinations could be made during the attacks and at intervals between them Gas was seen in the splenic flexure, but its volume was not larger during the attacks than during the intervals, nor larger than in healthy persons During the attack, however, there was a persistent longitudinal contraction of the descending colon (corde colique) which was not seen during the intervals Two of the patients were infested with *Endameba histolytica*, in 2 others, mucus was much increased in the stools It has been stated that an especially acute angulation of the splenic flexure is responsible for the symptoms, as it may cause gas to be trapped in this region, major surgical procedures have been performed upon this hypothesis In 100 unselected cases such an angulation was found in 28 instances in the absence of any pain

In patients with persistent or uncontrollable belching there is usually very little air in the stomach (Fig 8, b) The symptom may be observed in severe gastritis, and sometimes as the first manifestation of gastric cancer or its recurrence after resection Healthy persons who belch habitually are usually people who eat their food very hot They protect tongue and palate

by enveloping, as it were, the hot material with a layer of air which they suck or swallow together with the food, hence the musical performance offered on this occasion The man who sings his soup excites his gastric mucosa thermically and his gastric muscle mechanically, the combined stimulation results in belching But in routine examinations of 900 healthy medical students and student nurses, a very large gas bubble, occupying almost the whole left upper quadrant (Fig 8, a), was noted in 28 instances in the complete absence of any distress or belching

Clinical observations and electrocardiographic examinations have led some authors to conclude that increased gas in the stomach or splenic flexure may be responsible for cardiac symptoms or aggravate them On the other hand, when belching is frequent in cardiac patients, there is commonly not much air in the stomach Athletes know that belching after exercise may be a sign of exhaustion This is in accord with the following observation Of the 7 middle aged patients seen in whom a gastrocardiac syndrome had been diagnosed by eminent specialists, none survived the 3 years following the onset of symptoms Six died of coronary occlusion, and one succumbed to a peculiar type of general paralysis probably caused by cerebral and coronary sclerosis Hence the question may be asked whether gastrocardiac syndrome is not a manifestation of cardiac disease rather than its cause

Summing up these observations on gas pains, flatulent colic, belching, and gastrocardiac syndrome, the common denominator seems to be a disproportion between the amount of gas present and the contractility of the intestinal muscle Postoperative gas pains set in with the beginning effort of the recovering bowel to expel the gas

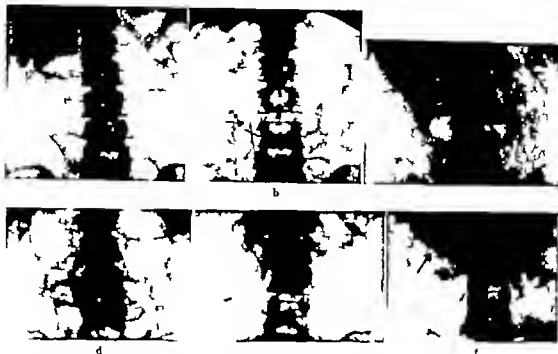


FIG. 9. A case of pyelitis before, a, and during, b, retrograde pyelography. Insertion of the ureteral catheter elicited gaseous distention. A case of renal calculi before, c, and during, d, retrograde pyelography. Intra-

venous injection of the dye elicited gaseous distention. A case of severe right hydronephrosis before, e, and during, f, the process of retrograde pyelography. A gaseous distention occurred.

accumulated during a period of atony. In flatule, colic and persistent belching, gas is not commonly increased, but the intestinal muscle is hypertonic or otherwise irritable. Experimental distention of a normal intestinal segment elicits severe distress (5). Indeed, in the conditions usually referred to increased gas, one often finds a reversed picture of that real gaseous distention which occurs during renal or biliary colic. In the latter, gas expands into the intestines which are widened by atony. In the former, gas is compressed as it were by increased muscular contractions. Accumulation of gas aggravates atony by interfering with intestinal blood circulation (8, 19). A vicious circle begins with atony and leads back to it. But the sensation of distention is produced chiefly by pressure of the gas upon which the intestinal muscle responds, unless gas is excessive, this sensation is not elicited in an atonic bowel.

Generally speaking, gas in the bowels does not cause pain unless the intestines are incapable of expelling it and at the same time sufficiently contractile to be stimulated by it. In other words, it is the tone of the intestinal muscle which determines the presence or absence of pain.

What tone is cannot be expressed easily. One may compare it to the tension of a drumhead. If this is high, the drumbeat will be elicited readily by slight strokes of the drumstick; if there is no tension, heavy strokes will not result in an actual sound. In this simile, in which the tension of the drumhead is the intestinal tone, the drumstick represents the intestinal contents and the drumbeat the intestinal activity. The 3 variables are interrelated and may combine in many ways.

THE PROBLEM OF THE ORIGIN OF THE GAS

No attempt has been made here to elucidate the origin of intestinal gas, since our studies were confined to the mechanisms of distention. It is held that most of the gas consists of air swallowed or sucked (4, 5, 6, 7, 9). Our observations on newborn infants confirm the view that air enters the stomach with the first breath (4). In adults, some gas can be seen to pass through the pylorus; some of it results from fermentation and putrefaction (5, 6) and most of it seems to be controlled by the respiration of the intestines. Thus the old theory that the intestinal tract takes part in respiration seems to become valid in the light

of recent investigations. This part of the problem is beyond roentgenological limits. The author did not find gas increased in cases of pneumonia in adults. In young children, the intestines are normally filled with gas. This may perhaps prove to be important in the future, in view of the fact that in early childhood some organs may retain or resume atavistic functions at certain periods of disease.

The above studies in man have not been amplified or confirmed by experiments in animals. The digestive tract of man differs essentially from that of animals, owing to the influences of domestication, of feeding habits, and of the upright posture. To problems like non-surgical meteorism, conclusions derived from surgical interferences on animals cannot be applied without some reserve. The work of Barclay and of Hurst, as well as the author's previous reports, suggest that the application to clinical medicine of conceptions derived from animal experiments has often delayed real progress. Hence, information on the normal and pathological physiology of man had best be obtained in man. The observations above recorded merely confirm clinical experience by adding some objective findings to the much undervalued knowledge that is based on clinical impressions.

THERAPY

Gaseous distention consists either in meteorism or in flatulence. Meteorism means increased gas in the intestines, flatulence signifies increased or frequent expelling of gas per rectum. Meteorism may be a cause of flatulence when the intestinal muscles are normally active, but flatulence may also occur when normal amounts of gas suffice to stimulate an irritable bowel. The sensation of gaseous distention depends chiefly upon the tone of the intestinal or gastric muscles, as already set forth.

In determining the appropriate treatment, one should bear in mind that flatulence usually indicates either that gas is produced in too large amounts in a digestive tract otherwise normal, or that an irritable tract responds by increased motor activity to the presence of gas. The two factors combine quite commonly (18), for example, abnormally increased fermentation may irritate the colon when the acid material is not well tolerated by it, or an acute indigestion may render the intestines sensitive to degrees of fermentation normally tolerated, whereupon a vicious circle may be set up. Hence, it is advisable to eliminate from the diet fermentable material as well as substances which may stimulate the colon mechanically. It is not necessary, and often



Fig 10. Roentgenograms of specimens of colon and small intestines removed 4 hours after death. No gas was insufflated, but the intestinal sections were ligated on either end before removal. Illustration shows the appearances typical of complete atony.

not adequate, to prescribe cathartics or other cleansing procedures, the colon needs cleansing very rarely anyway. Preparations containing diastatic enzymes are useful, but should be given preferably in liquid form. Fermentative indigestion is often associated with low gastric and intestinal secretory function, in which case drug coatings otherwise soluble may not be digested. Evidently when fermentation or irritability are part of some systemic disease, the latter has to be treated.

Meteorism, unless associated with flatulence, usually indicates diminished motor activity of the intestines, or of parts of them (8). Besides the acute abdomen and the reflex conditions here discussed, meteorism may occur in cardiac failure, portal congestion, abdominal shock, and other diseases in which blood circulation is altered in the intestines. The author found short-wave treatment useful in meteorism, probably because of the known effect of this therapy upon the local blood supply. When this improves, meteorism usually subsides by itself. As pointed out elsewhere (10), injection of postpituitary extracts is not always innocuous. In previous experiments, it was found that the colon does not respond to postpituitary extracts when it is physiologically contracted (10), recent observations suggest that it may also fail to respond when atonic (Fig 1, d). The excellent results of elimination of gas by suction (19) need not be discussed here.

SUMMARY

1. Both the amounts of gas present in the bowels and the symptoms induced by it depend on the intestinal tone.

2. Normally, by exciting peristalsis, gas is expelled almost automatically when it exceeds a

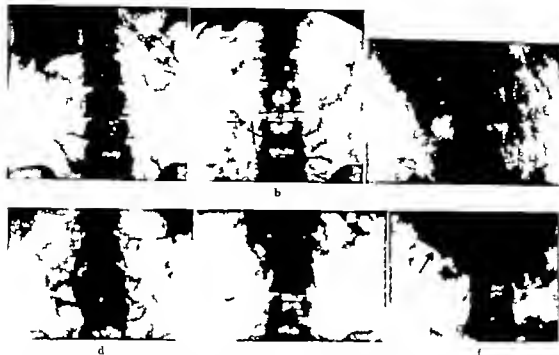


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SUMMARY

1 Both the amounts of gas present in the bowels and the symptoms induced by it depend on the intestinal tone.

2 Normally, by exciting peristalsis, gas is expelled almost automatically when it exceeds a

certain volume. Hence gas is not found increased within the normal bowels when it is produced abundantly, e.g. by fermentation.

3. When the intestinal wall is irritable and hypertonic small amounts of gas suffice to stimulate peristalsis and tend to be eliminated; this is felt as distention. Hence little gas is found as a rule in patients who complain of distention.

4. In the absence of pain and flatulence excessively large amounts of gas may fill the intestines when the bowels are atonic, owing to inhibitory reflexes which arise for instance in renal or biliary colic, pyelitis, appendicitis, etc.

5. Such an acute atony with sudden expansion of gas was produced experimentally in man by chemical or by mechanical stimulation of the viscera affected.

6. In the presence of gaseous distention distress and pain occur chiefly when the intestinal muscles are still contractile or when they resume normal motor function after a period of atony.

7. Experiments in man show that the gas which obscures the viscera on roentgenograms of patients with colicky pain is a sign of intestinal atony but not the result of increased fermentation. Waiting until the colic subsides is the best method of getting rid of this gas.

8. Persistent belching and gastrocardiac syndrome are independent of the amount of air present in the stomach. Observations are reported which suggest that gastrocardiac syndrome is a manifestation rather than a cause of cardiac disorder.

9. Meteorism not associated with pain is best treated by methods which improve the blood circulation in the abdomen. Flatulence due to fermentation or to colonic irritability is controlled by dietary measures, but not by cathartics and other cleansing procedures, since these tend to increase the irritation.

10. In view of the above results, the old clinical distinction between meteorism, increased volume and flatulence increased elimination of gas,

should be re-established, since the two conditions have little in common.

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THE MANAGEMENT OF DIVERTICULUM OF THE BLADDER

Ninety-Six Patients Treated by Transurethral Prostatic Resection

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UP to 1906 only 5 cases of diverticulum of the urinary bladder had been reported in the American literature, but since then improved diagnostic methods have resulted in the recognition of diverticula in a large number of cases

In structure, vesical diverticula may be large or small, single or multiple. Various depressions of the wall of the bladder often have been called "false diverticula" because they sometimes are deep and in some respects resemble true diverticula. True diverticula contain all coats of the bladder. The mucous membrane lining of a diverticulum is usually thin, the submucous coat also may be thin, but in many instances there is considerable inflammation which causes thickening of the wall, and this thickening is often proportionate to the amount of inflammation present. There may be variations in the thickness of the wall in different portions of the same diverticulum. The muscular layers vary in thickness and may be very thin, but some muscle fibers are always present. Muscle fibers are especially abundant at the orifice of the diverticulum, and some observers have mistakenly considered them to be sphincters. The size of the diverticulum may vary from that of an acorn to that of the bladder itself, it may be even larger. The most common situation of a diverticulum is near one of the ureteral orifices. Diverticula never arise directly from the trigonum vesicæ, although they are frequently encountered extending from the upper and lateral margin of the trigonum

CAUSATION

In 1913, one of us (1, 2) suggested that the word "diverticulum" should be confined to those pouches always of congenital origin, occurring most frequently in certain regions of the bladder, but occasionally encountered in almost any portion of it and not referable to defective development or lack of closure of any recognized structure.

Watson, in 1920, as a result of observations on fetuses concluded that "certain factors are present

which may be of importance in determining the formation of diverticula." He further stated "The site of transition from the trigone, with its thick musculature and its covering of many layers of epithelial cells, to the lateral bladder wall with only two or three layers of epithelial cells is prone to produce a ridge-like demarcation which readily lends itself to the formation of an excess of epithelial tissue. The apposition then of two surfaces of the bladder wall denuded of epithelium, at a time when true formative growth is active, results first in adhesions and later in a true attachment of a bridge of tissue across a portion of the vesical cavity. The growing submucosa and muscularis become continuous from the finger-like evaginations with that of the opposite side, and in the older specimens this ridge of tissue is shown to contain all three layers of the muscular coats of the bladder. The mucosa in its growth then becomes continuous from the finger-like evaginations with that of the opposite bladder wall, and there is formed a true pocket within the bladder, the walls of which have all the essential elements of the true bladder wall, namely, the three muscular coats, the submucosa and the mucosa."

Ward stated that diverticula were usually discovered in people past middle age and more frequently in the male, which suggested that their clinical recognition was hastened and their size was increased by any obstruction at the vesical neck which would bring about increased activity in the bladder musculature. It is interesting to note that patients afflicted by diverticulum of the bladder often have other conditions, such as inguinal hernia or diaphragmatic hernia, which indicate congenital weakness of the tissues.

TREATMENT

In 1918, Judd stated that the only satisfactory treatment of diverticula of the urinary bladder is radical excision, which should be followed and never preceded by prostatectomy. In some instances he combined the 2 procedures into a one stage operation. Except in occasional cases, we believe that when suprapubic prostatectomy and diverticulectomy are necessary, they should be done as a two stage operation and that diverti-

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Fig. Cystogram showing multiple diverticula. The prostatic gland, which weighed 69 grams, as removed by means of the first stage, suprapubic prostatectomy; the diverticula were not removed.

nectomy should always be the first stage procedure. In contrast, Howard stated in 1928 that the surgeon might first relieve the obstruction at the vesical neck by prostatectomy and subsequently treat the diverticulum surgically if symptoms persisted.

Kutzmann has stated that Diverticulum of the urinary bladder is treated most satisfactorily by the correction of the obstructing factors, only such diverticula being individually treated as may be of the retention type or of a large size. He reported 15 cases in which the patients were treated by bladder neck punch operations (1 open and 4 closed) for another patient prostatic resection was done with the high frequency loop. In reply to follow-up letters, most of Kutzmann's patients reported satisfactory results as evidenced by a marked diminution in symptoms and infection of the urinary tract, disappearance of residual urine and distinct gain in general health.

Ward recently reported 53 cases of diverticulum of the urinary bladder and concluded that "Cure is effected by diverticulectomy combined with treatment of obstruction if present. A careful search for this must always be made. In his series, 4 attempts were made to treat the condition by transurethral resection alone and all were unsatisfactory. One patient died and the others required diverticulectomy at varying intervals after resection.

Thus, there are two general doctrines (1) perform first diverticulectomy and at a later date suprapubic prostatectomy thus involving longer hospitalization, greater risk, and more expense, or (2) remove the obstruction of the vesical neck by transurethral resection and subsequently treat the diverticulum according to the patient's symptoms, a course which in our experience, involves much less risk.

For the sake of comparison we have reviewed the histories of 4 patients suffering from diverticulum of the bladder who were treated only by prostatectomy. The average age of these patients was 66.6 years. Each had a long history of urinary obstruction associated with frequency, nocturia, and difficulty in voiding. Seven of them suffered from complete urinary retention. Examination of the prostate by way of the rectum disclosed enlargement which could be regarded as a stage for the majority of patients. In the bladders of the patients having incomplete retention the average amount of residual urine was 278 cubic centimeters. The average value for blood urea was 44.5 milligrams per 100 cubic centimeters. Seven of the 4 patients had multiple diverticula of medium size (Fig. 1). The average weight of prostatic tissue removed by enucleation was 36.1 grams.

A follow-up study of these patients 3 years later disclosed that 1 had died from a cause unrelated to the urinary tract. In most instances, the postoperative convalescence was eventful and several patients suffered from epididymitis and cystitis shortly after discharge from the hospital. Generally 6 to 8 months were required before they were apparently well and feeling comfortable. None of these patients was subjected to diverticulectomy either prior to or in conjunction with prostatectomy. In cases such as these, even though the patients finally seem well there might develop in the diverticulum at a later date a condition requiring its removal. It is important to remember that diverticulectomy, undertaken after suprapubic prostatectomy is an operation considerably more serious than primary diverticulectomy for the marked pericyclic adhesions which inevitably follow suprapubic prostatectomy increase the technical difficulties and hence the risk of operation.

At The Mayo Clinic in recent years diverticulectomy has been done infrequently in fact, rarely for patients of advanced age. Instead, these patients have been treated by removing the obstruction at the vesical neck by transurethral resection. A series of 96 cases in which the patients were operated upon transurethrally during the years, 1932 to 1937 inclusive forms the

basis for this report. Although these patients were known to have one or more diverticula, they were treated by transurethral prostatic resection, either the Thompson or the Brunsch-Bumppus resectoscope being used. The average age of these patients was 65.3. Forty-one of the 96 were 70 years of age or older. All had pyuria. The average urea value was 40.5 milligrams per 100 cubic centimeters of whole blood. On rectal examination, the prostate glands of 88 of 96 patients were regarded as small or of moderate size. This is an interesting observation, because it is mistakenly believed by some observers that the prostate gland is large in patients of this type. The average amount of residual urine was 568 cubic centimeters. This includes 10 cases of complete retention in which the patients had huge, overdistended bladders. All the patients had one or more diverticula (Fig 2).

We have made an arbitrary division of the diverticula into small, medium, and large. There were 24 cases of small diverticula, which varied from 1 centimeter to about 3 centimeters in diameter. There were 55 cases of medium sized diverticula which varied from 3 centimeters to about 8 centimeters in diameter. In the 17 remaining cases the diverticula were about equivalent to the bladder in size and capacity.

These patients presented no associated lesions, such as carcinoma of the prostate gland or epithelioma within the bladder or within the diverticulum. The average amount of prostatic tissue removed at operation was 18.6 grams. This amount compares favorably with the average amount removed by suprapubic prostatectomy from the patients here discussed and with the average removed in any large series of transurethral prostatic resections performed on patients who do not have a diverticulum.

The immediate postoperative course for each patient was smooth and seemed essentially similar to that of any other patient subjected to transurethral resection, uncomplicated by the presence of a diverticulum. For 10 patients it was necessary to do 2 transurethral resections and for 1 patient 3 resections were done. These were performed at short intervals during one hospital confinement. For 8 of these patients the surgical risk was considered to be high because of the existence of hypertension and hypertensive cardiac disease. Several others had complications such as obesity, diabetes, carcinoma of the jaw, and Parkinson's disease. The patients were observed daily in the office after they left the hospital. The average amount of residual urine of all patients at the time of dismissal from our care was 47.3 cubic centimeters.



Fig 2 Excretory cystogram showing a large diverticulum arising from each lateral wall of the bladder. The diverticula were not removed, transurethral resection of prostatic tissue weighing 51 grams was performed.

All the patients were voiding comfortably and with few exceptions stated they were at that time almost completely relieved of their urinary complaint.

After carefully comparing these 2 groups of patients, the first group managed by suprapubic prostatectomy alone and the second group by transurethral resection, we believe that the latter operation is the one of choice and that with rare exceptions it should be performed first for all patients having diverticula and followed later by diverticulectomy if the subsequent course of the patient indicates the need for such an operation. For the majority of patients removal of the diverticulum, according to our experience thus far, will not become necessary. It should be noted that transurethral resection, in contrast with suprapubic prostatectomy, in no wise increases the difficulty or danger of subsequent diverticulectomy.

At The Mayo Clinic during the 6 years, 1932 to 1937 inclusive, even though an increased number



Fig. 3. Cystogram showing large diverticulum which had small tight orifice. Diverticulectomy was performed.

of patients suffering from urinary obstruction were treated only 30 primary and 5 secondary diver

ticulectomies were performed. In comparison, during the 6 year period, 1926 to 1931 inclusive, a period which was prior to the advent of transurethral resection 107 diverticulectomies were performed. Thus, it is evident that many patients who have vesical diverticula live comfortably after transurethral resection alone has been carried out.

As to the present indications for diverticulectomy we believe there are some rather definite types of cases in which diverticulectomy should be strongly considered. These are as follows (1) When the diverticulum is of medium or large size with a very small tight orifice through which drainage is unsatisfactory (Fig. 3) (2) In relatively young men having fair sized diverticula, even though there are no definite symptoms, but in whom the diverticula do not drain well after transurethral resection of the prostate (3) when there are complicating factors such as stone (Fig. 4) or carcinoma of the diverticulum and (4) when ureteral obstruction is caused by an adjacent diverticulum, and by dro-ureter and hydrocephalus result (Fig. 5) Occasionally nephrectomy will be necessary for such patients.



Fig. 4. Excretory cystogram showing dumbbell shaped stone, one end of which is thru diverticulum. Diverticulectomy and removal of the stone were performed. The smaller knob of the stone back projects into the bladder has broken off and is obscured by the media.



Fig. 5. Excretory program showing diverticulum causing ureteral obstruction. The ureter in its lower third portion, as is large as the small intestine. After stone nephroureterectomy and diverticulectomy were performed.

FOLLOW-UP STUDY

In order to check on this group of 96 patients, letters were sent to them inquiring about their general health and the status of their urinary tract. This method is not very accurate, but it provides information of some value.

Forty-three patients of the group of 96 stated that they had no trouble at all in urinating. The others reported in a more qualified manner by saying that "most of the time" they had no trouble in voiding. Others said there was occasionally some sensation of burning on urination and a few had definite difficulty. As to the appearance of the urine, 37 patients said their urine was "clear." Nine patients said their urine was definitely dirty, while the others said their urine appeared to be hazy, or occasionally hazy, or occasionally dirty.

Concerning residual urine, of 29 patients who gave a definite reply on this point, 8 patients had no residual urine when examined by a physician. The bladders of 15 other patients at catheterization disclosed residual urine under 100 cubic centimeters in amount. Six patients stated that catheterization had revealed residual urine in quantities from 100 to 200 cubic centimeters. Several other patients gave vague reports concerning the question of residual urine or reported that they had no reason to suspect that any existed. A few patients had been checked by a physician but were not informed as to the amount obtained by him. Several patients thought that at times the bladder seemed to fail to empty completely, while at other times urination seemed complete.

Thus, it appears that the majority of these patients state that they "can urinate all right" and that although a number of them have small amounts of residual urine, symptoms which the home physician thought sufficiently important to require the patient to return to the clinic with a view to surgical treatment, have not appeared.

Of particular interest are the 17 patients having large diverticula. Only one man in this group experienced trouble after going home. He was 58 years of age and had 2 diverticula of large size, and although urinary difficulty has been eliminated, he probably will need diverticulectomy. He intends to return shortly for further study. The 16 other patients who had large diverticula

now have intermittent complaints of a very minor nature which are being easily managed by their home physician. The majority of them are patients 70 years of age and more who readily agree with their family physician and the authors that the small amount of residual urine occasionally found is unimportant.

SUMMARY AND CONCLUSIONS

1 Diverticulum of the urinary bladder is of congenital origin and generally causes no symptoms until obstruction develops at the vesical outlet, the obstruction usually is caused by benign prostatic hyperplasia, but may be the result of contracture of the vesical neck, congenital obstruction, or prostatic carcinoma.

2 If the obstruction at the vesical outlet is to be removed by suprapubic operation, it is best to precede this operation by diverticulectomy, generally as a first stage procedure.

3 In the large majority of instances, thorough transurethral resection of the tissue obstructing the vesical neck will relieve the patient's symptoms and diverticulectomy will not be required.

4 If the patient's symptoms are not satisfactorily relieved, diverticulectomy can be done subsequent to transurethral prostatic resection, the latter operation in no way adds to the technical difficulty of removing the diverticulum.

5 An analysis of the results obtained for 96 patients who were treated only by transurethral resection of the obstruction at the vesical neck warrants the conclusion that in the age group of patients likely to have prostatic disorders, the risk, discomfort, and prolonged hospitalization incidental to diverticulectomy can almost always be avoided.

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RESULTS OF AMNESIA AND ANALGESIA IN 175 CONSECUTIVE CASES OF LABOR

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IN the early nineteenth century Sir James Y. Simpson and Walter Channing (10) were the first men to make a real attempt to relieve the pain of labor. There has been considerable controversy since then regarding the advantages of the production of complete amnesia and analgesia during labor. From a review of the more recent literature we find that the obstetricians who have given this method a fair trial in a series of consecutive cases have obtained results which would warrant its further employment (3, 4-9, 16-20). Whereas the ideal analgesic has not yet been found and the results have not been perfect, experience in this field has shown that persistent efforts toward attaining an ideal analgesic ultimately should prove successful.

We are presenting our experience in the production of amnesia and analgesia during labor as being indicative to some extent of its efficacy and also in the hope that it might be added to the series of cases favoring analgesia in labor already reported in the literature. From our experience we are firmly convinced that this plan of treatment can be followed with safety both for the mother and the infant.

In our use of the term analgesia we refer to the standard definition of the absence of sensibility to pain, whereas amnesia has been defined as the loss or lack of memory, especially the inability to remember.

One hundred seventy-five patients have been treated with varying combinations of drugs in the attempt to induce amnesia and analgesia. The first group was given pentobarbital sodium in doses varying from 6 to 7½ grains by mouth and 150 grain scopolamine subcutaneously following the method described by Irving. The second group was given 3 grains of pentobarbital sodium by mouth followed by 5 drams of paraldehyde in 5 drams of aromatic elixir orally as described by Douglass and Peyton (8). The third group received varying doses of pentobarbital sodium alone. A few patients in whom there was extreme restlessness, were given a combination of ethyl paraldehyde and olive oil per rectum. All of the patients were given either a combination of

From Northwestern Hospital.

trous oxide and oxygen by inhalation or drop ether at the time of delivery.

The object of the procedure is to secure complete amnesia from the time the drugs are first administered until the patient awakens in her room following her delivery. In primiparae the indications for medication are as follows: good contractions at 3 to 5 minute intervals and dilatation of the cervix of from 2 to 3 fingers. In multiparae the medication is begun when there is about 2 fingers dilatation of the cervix regardless of the frequency of the pains.

It has been noticed that in cases in which the patient is complaining of pain before the cervix has reached the dilatation described it is possible to get better results if the drug is given early, provided of course the patient is in active labor. A nurse is in constant attendance at the bedside from the time the first dose of pentobarbital sodium is administered until the patient awakens in her room.

In our series of 85 primiparae and 90 multiparae, the best results with relation to amnesia and analgesia were obtained in the group which received pentobarbital sodium and scopolamine and the duration of labor and the average time between the administration of the medication and delivery were the shortest. Complete or partial amnesia was obtained in 100 per cent of the primiparae and 97 per cent of the multiparae. The average duration of labor for the primiparae was 1.4 hours as compared to 9.6 hours for multiparae and the primiparae were under the influence of analgesics 6.5 hours, whereas the multiparae were under analgesics only 3.4 hours. These results are in agreement with the work of Irving and his co-workers, Grier, Gould and Hirst, and Hunt. Four primiparae in this group were classed as morbid by the standards of the American Committee on Maternal Welfare. The 4 patients exhibiting degree of restlessness requiring additional medication were in this group of the multiparae. The 3 fetal deaths in this group cannot be traced to the use of the analgesic.

The duration of labor and the length of time from the administration of the medicine until delivery were the longest in the group receiving the combination of pentobarbital sodium and paral-

dehydrate in aromatic elixir by mouth. The duration of labor for the primiparae was 23.3 hours as compared to 11.9 hours for the multiparae. The primiparae were under analgesia on the average of 10.6 hours whereas multiparae were under the influence of drugs 5.7 hours.

The results were the poorest with regard to amnesia in the group receiving pentobarbital sodium in doses varying from 3 to $7\frac{1}{2}$ grains. Complete or partial amnesia was obtained in 54.4 per cent of the cases in the primiparae and 60.7 per cent of the multiparae. Three patients were classed as morbid in this group and there were 3 fetal deaths.

The involuntary reactions of a patient in an amnesic state necessitate its contra-indication in patients denied the constant supervision of a trained nurse or physician. This is important to avoid self-injury or self-contamination of the patient, for even though she appears quite relaxed, she may be having strong uterine contractions. This procedure is contra-indicated in patients who have suffered recent upper respiratory infections, as this precludes the use of an inhalation anesthesia. Recent ingestion of food is to be avoided by patients if this medication is anticipated as vomiting with resulting aspiration of the vomitus might occur due to the diminution of the gag reflex. Galloway et al. (12) add to the above contra-indications, prematurity and heart disease. We do not think that patients with heart disease should be denied the use of the analgesic, as it enables them to rest between pains, thus conserving their strength, and we believe that such patients should be delivered by prophylactic low forceps as soon as dilatation is complete. It did not seem to us that the use of the analgesic interfered in any way with the safety of the premature babies in our series.

Since the ideal analgesic has not been found, obstacles will be encountered, which, we believe, with improvement in technique will be greatly diminished. As Bill has so aptly stated, "the real question today is not whether to make labor painless but how to do this in the best way." Among the more common objections to this procedure is the asphyxiated condition of the infant. Although 26 of the infants in our series required resuscitation by means of tracheal catheter, there were no serious cases, and no fetal deaths in the group can be attributed to the drugs used. Similarly, Colvin and Bartholomew noted that slight stimulation by spanking usually sufficed to establish good respiration in the normal, full-term babies who exhibited some degree of apnea or sluggishness. A brief survey of some of the more recent reports in

the literature (3, 6, 7, 8, 16, 19) is in accord with our findings as regards apneic babies. Whereas some of the mothers have felt rather sleepy during the first 24 hours, none have suffered effects more serious than this. Every mother in our series who has had deliveries both with and without analgesia is in favor of the method. Other authors, Galloway (11), Damon, etc., have reported this same reaction of the mothers.

A frequent objection which arises with regard to the employment of analgesia during labor is an unusual degree of restlessness observed necessitating restraint or a constant attendant to prevent serious injury or self-contamination. Although this may be partially true, this close attention gives the nurse an unparalleled opportunity to follow the course of labor. In our entire series we observed an exhibition of this reaction only 4 times, an incidence of 2.3 per cent, which is the approximate percentage reported by Daichman and Shur. The highest percentage that we could find from a review of more recent articles was Brown's series which was 13.8 per cent and the lowest was reported by Boylan, 3 cases in 205 or 1.5 per cent. Colvin and Bartholomew point out that restlessness is most marked in highly nervous or excitable patients, who would be noisy and restless without medication, but whose reaction is only accentuated by the administration of barbiturates. We have found that this restlessness is easily controlled by nurses, and additional medication by rectum can be given if necessary.

The opposition to this method offer as an argument that the operative incidence is increased under this treatment. In our series of 175 cases 40.1 per cent of the patients had operative deliveries of which 86 per cent were prophylactic low forceps and 14 per cent other types of operative deliveries. However, a comparative study of 74 prophylactic low forceps deliveries and 74 spontaneous deliveries in our series revealed that the prophylactic deliveries have the better results. Many men advise prophylactic low forceps in every case. Galloway and Smith (12) noted an increase in outlet forceps. In their series of 275 cases 85 per cent were delivered by some operative procedure. Of these operative cases 81.2 per cent were prophylactic low forceps and 18.9 per cent were other operative procedures. Irving reports an operative incidence of 35.6 per cent in 860 cases using 8 different types of analgesics as compared with an incidence of 44.6 per cent in 1920 when no relief for pain during labor was attempted. In the 100 cases having pentobarbital sodium and scopolamine the operative incidence was 30 per cent.

Our results in general have been in agreement with other series reported in that it is possible to produce amnesia and analgesia without demonstrable harmful effect on either the mother or baby. It has not increased the incidence of operative deliveries other than a more frequent use of prophylactic low forceps. The procedure undoubtedly increases the amount of attention which the obstetrician must give to the patient, but this can hardly be construed as a criticism of the method. We have observed that the patients who have received this type of treatment have convalesced more rapidly than the others who were not so treated and we have seen no cases of mental confusion or depression following the use of the medication.

SUMMARY

In our series of 85 primiparae and 90 multiparae treated with varying combinations of drugs to induce amnesia and analgesia, complete or partial amnesia was obtained in 90.3 per cent of the cases, whereas poor amnesia was noted in 9.7 per cent. The total operative incidence was 49 per cent of which 86 per cent were prophylactic low forceps deliveries. There were no maternal deaths in the series. The fetal mortality for the entire series was 3.4 per cent and maternal morbidity 4.6 per cent. The combination of pentobarbital sodium and scopolamine has been most satisfactory in our hands.

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EDITORIALS

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JANUARY, 1940

GUNSHOT FRACTURES AND THE INFREQUENT DRESS- ING METHOD

SOON after our military experience in 1919, it was suggested that immobilization in plaster-of-Paris casts and the infrequent dressing method be tried in our post-war hospitals. A better method was needed for the many cases of chronic osteomyelitis for which the antiseptic irrigation and dressing methods, then in use, had failed to produce cures.

The program proposed in 1923 was (1) to immobilize the injured or inflamed limb in correct length and position on the fracture table before operation, (2) to operate with drainage as the principal consideration, (3) to dress the wound open without sutures or drainage tubes, vaseline pack preferred, (4) to put the wound and the limb at rest by immobilization in an extensive plaster-of-Paris cast with skeletal fixation by ice tongs or pins included in the cast, and (5) not to disturb the limb and the

wound for dressings. This last point was designed particularly to exclude secondary infection from the wound area and to afford an interval of rest for the limb and the wound in correct position. This is important not only for healing but to favor circulation and the other physiological functions.

Recently there are many who think that wound infection, delayed repair, and even non-union of fractures are due to deficient calcium. They suggest local injections or general medication. Dr. Clay Murray of New York points out that injections at the fracture site accomplish nothing more than to cause local damage and to recreate, in a degree, conditions similar to those which followed the fracture. In this way, Dr. Murray thinks, a new effort at repair may be initiated, but that the chemical contribution is unimportant. It would seem, really, that it is much better to provide correct position of all the parts at once and thus encourage proper function in the injured limb. We have shown that we can do this if we use all the orthopedic and other resources at our command to fortify and protect the patient. This is certainly better than it is to re-injure the limb, by injection or operation later, in an effort to produce conditions as favorable to repair as those which naturally follow the primary injury.

Some of the earliest patients treated by the infrequent dressing method, astonished everyone by their ability, under the conditions here outlined, to recover. Moreover, such clinical experiences have now been repeated in many countries and on so many occasions that upon clinical considerations alone the infrequent dressing method has been widely adopted.

Now comes a military surgeon¹ who reports 1,073 gunshot fractures including 122 of the femur 261 of the upper arm and shoulder and 268 of the leg, with only 6 deaths. He does not hesitate to attribute his remarkable results to the infrequent dressing method and goes so far as to say that in his opinion this method "has given a new direction to surgical practice.

Two difficulties have obstructed the progress of the infrequent dressing method. The first is the use of weight and pulley traction. Hugh Owen Thomas taught us how to use fixed traction in Thomas splints and Sir Robert Jones disseminated this teaching even to the battle field. But fixed traction has not yet been generally adopted and it makes progress slowly. Skeletal fixation devices in plaster will give far better control than elastic traction or any adjustable mechanical device. To employ weights and pulleys either for primary reduction or continuous control whether for days or weeks is obviously from the physical viewpoint, absurd.

Treuta had only 6 deaths in his 1,073 cases. Moreover although most of these came from the battlefield or were collected in Barcelona following air raids, there was an almost complete absence of gas gangrene in his cases, because tissue pockets were left open in the wounds and injured extremities were immobilized at once in plaster-of-Paris casts. Even the most severe cases were left a week or 10 days without change and final healing was instituted before there was any repetition of trauma (by dressing) or exposure of the wound to secondary infection. Tetanus antitoxin was given to all of his patients.

To those who are still concerned about local organic or inorganic chemistry (calcium, magnesium extract, bacteriophage) in the wound area or in the blood, it should be a final answer that

¹ J. Treuta. *War Wounds and Fractures*. London: H. K. Lewis, 1939.

unless the patient's blood chemistry or body metabolism can be shown by the usual clinical tests to be out of adjustment, neither local nor general therapy will be required. If the surgeon will restore all the injured parts to correct position and favor physiological return by heat, circulation, and other usual means, the local chemistry not only for repair but for resistance to such infection, as is ineradicable by surgery will take care of itself.

We should remember that suppurative processes stimulate osteogenesis. In compound fractures, if anatomical restoration of parts is obtained and unless the patient is overwhelmed by infection, repair of the fracture and healing of the wound will occur as rapidly as in any other local traumatic or inflammatory affair. The surgeon must "set the limb not the fracture alone and then arrange for postoperative care which will insure the patient against local trauma and repeated infections.

H. WINNETT OAK.

THE RATIONAL MANAGEMENT OF THE MENOPAUSE

TO begin with something of a platitude, the menopause is one of the normal transition phases through which every woman must pass if she lives long enough. Since the cessation of the menstrual function is only one of the manifestations of this transition, the term "climacteric," derived as it is from a Greek word meaning "rung of a ladder" is a better one than menopause.

The popular concept of the climacteric is still heavily laden with fallacies, such as the supposed causal relation to cancer and insanity or the fear that the menopause means the end of the woman's sex life. As a matter of fact, there are not a few women to whom the climacteric comes as a sort of boon, transforming many a thin, scrawny worried mother after years of childbearing and do-

mestic worry, into a plumper, serene type of matron, a sort of second flowering

What is the cause of the menopause? This can be definitely answered by stating that the prime cause is the fact that at this time the ovary reaches the end of its functional life span. In spite of the generally dominating control of the anterior pituitary over the ovary, the cessation of ovarian function is not due to cessation of hypophyseal gonadotropic activity, which continues beyond the menopause.

The characteristic hormonal picture after the menopause, therefore, is an absence of estrogen and a persistence and relative excess of gonadotropic hormone. The final cessation of estrogenic function may be preceded by a phase of estrogenic excess, characterized clinically by functional bleeding.

There has been some discussion as to whether the characteristic vasomotor symptoms are due to the increased pituitary or to the decreased ovarian function. While the latter is the underlying factor, it seems likely that the pituitary overactivity is linked up with the immediate mechanism of the symptoms. There is considerable evidence to indicate that in the pituitary there is a liaison with the cerebrospinal nervous system. We are entirely ignorant as to the pathways between the pituitary and the various brain centers, such as the vasomotor areas. And yet the characteristic vasomotor flushes of the climacteric are closely allied to such vasomotor phenomena as blushing, and it seems certain that the endocrines act by way of the vasomotor system to bring about these characteristic phenomena.

The occasional persistence of estrogen in the urine of women long after the menopause, or long after castration, has been noted by many observers, but the explanation for this is not yet clear. While some believe that the postmenopausal estrogens are chemical metabo-

lites of sterol substances, it seems more likely that they may be produced by other endocrine glands, such as the adrenal cortex.

It must not be supposed that all menopausal women require medical management, for this is far from the case. In this connection two general statements may be made, namely (1) In only a minority of women are menopausal symptoms sufficiently disturbing to impel patients to seek medical treatment, and (2) many symptoms are wrongly attributed to the climacteric, sometimes for no reason than that they occur in the fifth decade of life. The first of these statements can be easily substantiated by questioning any large series of women who have passed through the menopause.

With reference to the second generalization, it should be emphasized that the only symptoms clearly due to the endocrine readjustment of the climacteric are the vasomotor group, i.e. the flushes, sweats, and hot flashes. This is not to say that no other symptoms can be of endocrine causation, but the latter is difficult to establish in the case of such symptoms as headache, irritability, emotional instability, insomnia, and many others which are often considered menopausal but which are common in many functional nervous disorders. They are often purely secondary to the apprehensiveness and general disturbance produced by the more characteristic vasomotor phenomena. At any rate, the latter are more nearly objective than any of the others, and they must therefore serve as the chief criterion in evaluating the results of treatment.

On the other hand, any one who treats menopausal women in a coldly objective way, and without considering the entire physical and psychic background of the patient, will fall far short of the requirements in many cases. Organotherapy is only a part, and often a negligible part of the management of menopausal women.

The fact remains, however, that a certain proportion of women suffer with severe vasomotor symptoms for a variable and unpredictable time and that the lot of these women can be made much easier by intelligent organotherapy. Whereas formerly there was much difference of opinion among clinicians as to the efficacy of hormone treatment, opinion is now unanimous that it is of genuine value. In fact, organotherapy for menopausal symptoms is looked upon as one of the more satisfactory applications of endocrine knowledge in the field of gynecological practice.

We have advanced far since the early days of ovarian therapy when tablets or capsules of ovarian extract, corpus luteum and ovarian residue constituted our therapeutic armamentarium. Looking back at this epoch, we know that all these older preparations were entirely or almost entirely inert. Now we have available physiologically effective preparations of both ovarian hormones; we know the exact chemical composition of these hormones, and they can be prepared in crystalline form even synthetically. There is no longer any excuse for the employment of the older inert preparations, though they are still manufactured and sold in considerable quantities.

One disadvantage of endocrine therapy in menopausal as well as other gynecological conditions has been that of the relative expensiveness of these products. There has been, therefore, much recent interest in the so-called stilbene derivatives, the best known preparation being stilboestrol. These substances are chemically not related at all to the natural hormones, but it seems generally agreed that they are as estrogenic as the hormones themselves, and as effective as the latter in such

clinical indications as the menopausal syndrome. They are not yet available commercially because there is still some doubt as to the question of their toxicity.

There have been many reports of nausea and vomiting from their use, although, in moderate dosage, I have noted these symptoms in only a comparatively small portion of patients. The great advantage of these substances, aside from expense, is the fact that they are very efficacious by the oral route. It seems highly probable that biochemists will be able to eliminate the factor of possible toxicity, and that substances of this general group will come to play an important part in the future treatment of menopausal symptoms.

Finally, one frequently hears the question raised as to whether estrogenic treatment may not carry with it some danger of promoting the development of cancer. This fear is based upon the demonstrated relationship between estrogenic and carcinogenic substances, and upon the fact that in some experimental animals it has been possible to produce cancer-like processes in such organs as the breast and uterus by very large estrogenic dosage. There is, however, no clinical evidence to substantiate this fear, and even huge doses of estrogen given for considerable periods of time have appeared to produce no noteworthy permanent effects. Moreover, it must be remembered that the doses used in the experimental production of cancer in animals were many times as great as, in the human scale, would ever be used for therapeutic purposes. It seems safe to say, therefore, that in the use of estrogens in the doses commonly employed, the fear of promoting cancer development may be disregarded.

EMIL NOVAK

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

DISCUSSIONS of the problems of electrosurgery with reference to its indications and operative technique have often appeared heretofore in so fragmentary and disorganized a manner that one must regard the book, *Clinical Electrosurgery*,¹ as a timely contribution because it attempts to organize and classify this relatively new phase of general surgery. According to the author, electro-surgery should be regarded as an essential and under certain conditions indispensable part of general and special surgery but no more than that. The book aims at summarizing the facts which may be accepted as proved in the present stage of our knowledge of this particular field. The task of epitomizing this subject in one volume is a difficult assignment and the author is to be congratulated on the degree to which he has fulfilled his purpose.

As this volume is limited to the exposition of basic principles and essentials, the author should have endeavored to present a more complete bibliography as a complement to his text. In spite of his statement that no attempt has been made to include everything that has appeared in the literature, the critical student of this subject would welcome added information by collateral reading, the sources of which might have been given in greater detail. Thus, in the chapter devoted to operations on the female pelvis the author has restricted the bibliography to but 5 references, 3 of which date back 30 years. However, it should be pointed out that these are first and original contributions revealing an intensive search into original sources.

The book is divided into 2 parts the first of which is devoted to a general consideration of a theoretical and technical nature. The second part presents electrosurgical operations proper. As surgical judgment and experience are of paramount importance, the work stresses that the surgeon must have mastered thoroughly the special fields before he attempts to perform operations by means of electrosurgery. It is readily appreciated that a single volume covering the general and special fields of electrosurgery must of necessity be restricted to a text that is terse and somewhat sketchy, a framework which may not fully satisfy the surgeon who wishes to prepare himself for actual clinical work. Nevertheless, the contents are sufficiently informative and lucid to consider it a timely contribution because it presents not only advantages but also limitations of this special method of surgery.

JOHN S. COULTER

BIOGRAPHIES are frequently dull things, pertinent so often to isolated and unreal interests and characters, and are so replete with listless pages that one skims the surface or puts the book down in despair. None of these things are true of Fischer's *William B. Wherry, Bacteriologist*.¹ It is alive with interest on every page. It is in fact two biographies in one, one intermingles with the other. It is the picture of a man, born and tutored in a strict religious environment, who reached eminence in his chosen field, coupled with the smaller portrait of a family restricted financially yet spurred back and forth between India and the United States by the conviction of divine guidance and help in their missionary endeavors.

Much of the book consists of letters from the subject himself, which makes the picture more clear and the story more real. Included are the first letters he wrote at age of 13 while in the country, those from Washington and Jefferson in which his chief concern seemed to be the fact that he was draining the already depleted family purse, and later those from Rush Medical College, where he was thrown with some of the great teachers and research men of the time, and the thoroughness of their influence is clearly shown throughout his life. There, too, he was taught by Herrick, Billings, Sippy, Fenger, Senn, and many others.

However, the man who influenced him most and whose opinion and approval he sought through the years was Hektoen into whose laboratory he gained admittance, where "weak men and the preternaturally bright died on Hektoen's treadmill." It left men like Wherry to be put upon "problems." After receiving his medical degree in 1901 he spent a busy year and a half at the University of Chicago as assistant to Jordan in bacteriology. In 1902, he was appointed bacteriologist to the embryo government laboratory in Manila, and the reports published by him during that time are evidence that he was fast acquiring the mind of a true scientist. His publications were of a diversified nature such as "Hand Infection" and "Bacterium Mallei," but he wrote more particularly on the plague which was to engage his interest for many years. From Manila he journeyed to India to visit his parents and then back to the United States where his never failing friend Hektoen found a place for him in Anaconda a field ripe for research and public health measures both of which profited by Wherry's activities.

The Oakland College of Medicine claimed him next as professor of parasitology and shortly after

¹CLINICAL ELECTRO-SURGERY. By Gustavus M. Blech, G.C.S. C.C.G., M.D., LL.D. With chapters by Hecto Alfred Colwell, M.B. Ph.D., D.I.H., L.R.C.P., M.R.C.S. and Brian Wellington Winlover, L.R.C.S. D.M.R.L. London, New York, Toronto, Oxford University Press, 1935.

WILLIAM B. WHERRY, BACTERIOLOGIST. By Marjorie Fisher. Springfield, Ill. and Baltimore, Md. Charles C. Thomas, 1935.

the reappearance of the plague in that area caused him to be invited as bacteriologist to San Francisco a health board, and the following year he was appointed as temporary acting assistant surgeon in the United States Public Health and Marine Hospital Service for duty in Oakland. It was there that his discovery of the plague in ground squirrels brought him prominence. In 1909, he accepted the assistant professorship of bacteriology with time stipulated for research, in the reorganized Ohio-Miami Medical College of the University of Cincinnati. Immediately and continuously he played a conspicuous part in the building up of this institution which was to be the center of his activities for the remainder of his rich and productive life which was terminated by

death in 1936. Noteworthy were his investigations on the action of emetine, the acid fast bacteria, tetanemia, the cultivation of organisms under gas tensions, vaccines, and immunity. The biography contains a list of Wherry's publications.

Wherry's position in science is due to real merit and not to self-promotion. It is clear he loved his science, not for science alone but fully as much for what science might do for mankind. This admirable character has been lovingly and understandingly portrayed by his friend and colleague, Martin Fischer. The volume, issued in de luxe format, is a fine example of the art of bookmaking and a fitting frame for a fine and accomplished man.

ALEXANDER A. DA

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

HOSPITAL FOR THE RUPTURED AND CRIPPLED. HISTORICAL SKETCH WRITTEN ON THE OCCASION OF THE SEVENTY-FIFTH ANNIVERSARY OF THE HOSPITAL. By Felix Beckman, M.D. With foreword by Philip D. Wilson, M.D. New York: The New York Society for the Relief of the Ruptured and Crippled, 939.

TUMORS OF THE HAND AND FEET. Edited by George T. Pack, B.S., M.D. F.A.C.S. St. Louis, C. V. Mosby Co. 939.

THE SURGERY. INJURY AND PLASTIC REPAIR. By Samuel Forson, Ph.D. M.D. A. Williams & Wilkins Co. Baltimore. The Williams & Wilkins Co. 1939.

NEUROLOGIC-LARYNGEAL MEDICINE OF THE EAR. Edited by Edmund Prince Fowler, J. M.D. Sc.D. With foreword by John Devereux Keenan, M.D. New York and Edinburgh: Thomas Nelson and Sons, 939.

ELECTROCARDIOGRAPHIC PATTERNS, THEIR DIAGNOSTIC AND CLINICAL SIGNIFICANCE. By Arlie R. Barnes, M.D. Springfield, Ill., and Baltimore, Md. Charles C. Thomas, 940.

EXERCISING GYNECOLOGY. By E. C. Hambley, B.S. M.D. F.A.C.S. Foreword by J. B. Collip, M.D. Springfield, Ill. and Baltimore, Md. Charles C. Thomas, 939.

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MEASUREMENTS OF UTERINE CONTRACTIONS IN LATE PREGNANCY

A Study of Five Patients with the Lóránd Tocograph

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INADEQUATE uterine power continues to be one of the commonest causes of difficult labor. One method of attacking this problem would seem to lie in securing a better understanding of the characteristics of the uterine movements themselves. It would appear not unlikely that there might be some sequential relationship between the prelabor and the labor contractions. With these ideas in mind a study is being made of the uterine activity both before and during labor. The present report concerns the former, it deals with the magnitude of the movements which take place during the last 2 months of pregnancy, and especially with the changes which they exhibit as labor is approached.

LITERATURE

A number of techniques have been devised for the purpose of recording the nature of the uterine movements. Kristeller estimated indirectly the amount of force necessary to expel the fetus by utilizing a dynamometer in the handles of an obstetrical forceps. Poppel measured it in terms of the amount of force required to rupture amniotic membrane.

Schatz determined the intra-uterine pressure directly with a rubber balloon inserted into the laboring uterus. Pouillet combined a rectal balloon with the uterine balloon of Schatz, in order to measure the extra-uterine pressure created by the contraction of the abdominal muscles. Since the direct method involved the invasion of the uterus during labor, it was obviously impractical, if for no other reason than because of the danger of sepsis. This objection, among others, led to the search for a more practical method.

Schaeffer was the first observer to record the uterine movements mechanically through the medium of the abdominal wall. He applied an air-inflated, dome-shaped apparatus to the abdomen which was connected to a recording device. Ruebsamen registered the changes in the contour of the abdominal wall by placing upon it a 500 gram weight connected with a recording lever by means of a piece of string. Crodel appears to have been the first observer to pick up the abdominal movements by means of a movable metal rod and lever arrangement. Dodek placed a rod between the abdomen and an air-filled tambour, making permanent records upon a smoked kymograph paper. Frey, using the rod and lever principle, secured a permanent record

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with ink, the tracing taking a circular direction. Rech interposed an electrical system between the apparatus which picked up the abdominal movements and the recording device. Lóránd (5, 6) improved upon Frey's method by having his permanent record in a lineal rather than in a circular direction. He has constructed 3 different tocographs, the second of which was used for the present study.

MATERIALS AND METHODS

Recording device. The Lóránd tocograph, which was employed in the present study (6), consists of a set of levers enclosed in a metal box 9.5 by 11 centimeters square, by 6 centimeters high. It is fastened to the abdomen with an elastic belt. Changes in the contour of the abdominal wall which take place with

each uterine contraction, are registered by a movable metal rod 6 millimeters in diameter which, when at rest projects 5 millimeters from the bottom of the box. The rod, requiring a weight of approximately 150 grams to displace it, operates a writing point at right angles to a strip of millimeter cross section paper the latter being moved by clockwork at the rate of 1 millimeter in 15 seconds. The excursion of the pen is 7 times greater than that of the rod in contact with the abdomen.

Method of securing records. Patients attending the prenatal clinic of the Hospital of the University of Pennsylvania acted as subjects. They were selected at random except for the fact they were primigravidae and at least 32 weeks pregnant at the start of the study.

All records of a patient were made at her home and each tracing was secured at the same time of day. For the recording she assumed the semi-recumbent posture with her shoulders supported by a felt pillow. After a rest period of 10 minutes the tocograph was strapped to her abdomen, cephalad, but close to the umbilicus. Each tracing period lasted 1 hour during which time the patient reported the sensation which accompanied any intra-abdominal movement. Each patient was observed on an average of 3 times a week, the last tracing being made a day or two before the onset of labor. Five women were studied, 1 for 8 weeks, 2 for 7, 1 for 5 and 1 for 3 weeks. One hundred six daily records were secured these represented approximately 120 hours of observation and registered 1,377 uterine contractions.

RESULTS

Observations made during the recording period. The tocograph recorded sneezing, coughing, vomiting, laughing, fetal movement, and uterine contractions but did not pick up maternal respiration or intestinal action. With the patient quiet only uterine contractions and fetal movements were registered the former created waves, and the latter vertical lines upon the tracing paper.

Many uterine contractions were accompanied by a sensation of tightness in the abdomen. Its degree was in proportion to the height of the recorded wave and the tenseness of the abdomen.

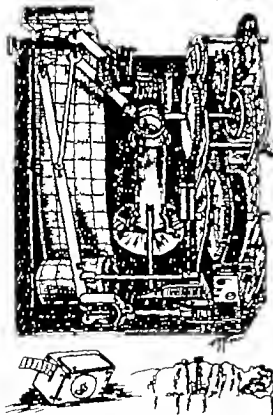


Fig. Lóránd tocograph, interior and exterior views, and in position for recording. Movable button protruding from bottom of tocograph (lower left) operates system of levers, which move writing point at right angles to strip of cross section paper, which in turn is motivated by clockwork.

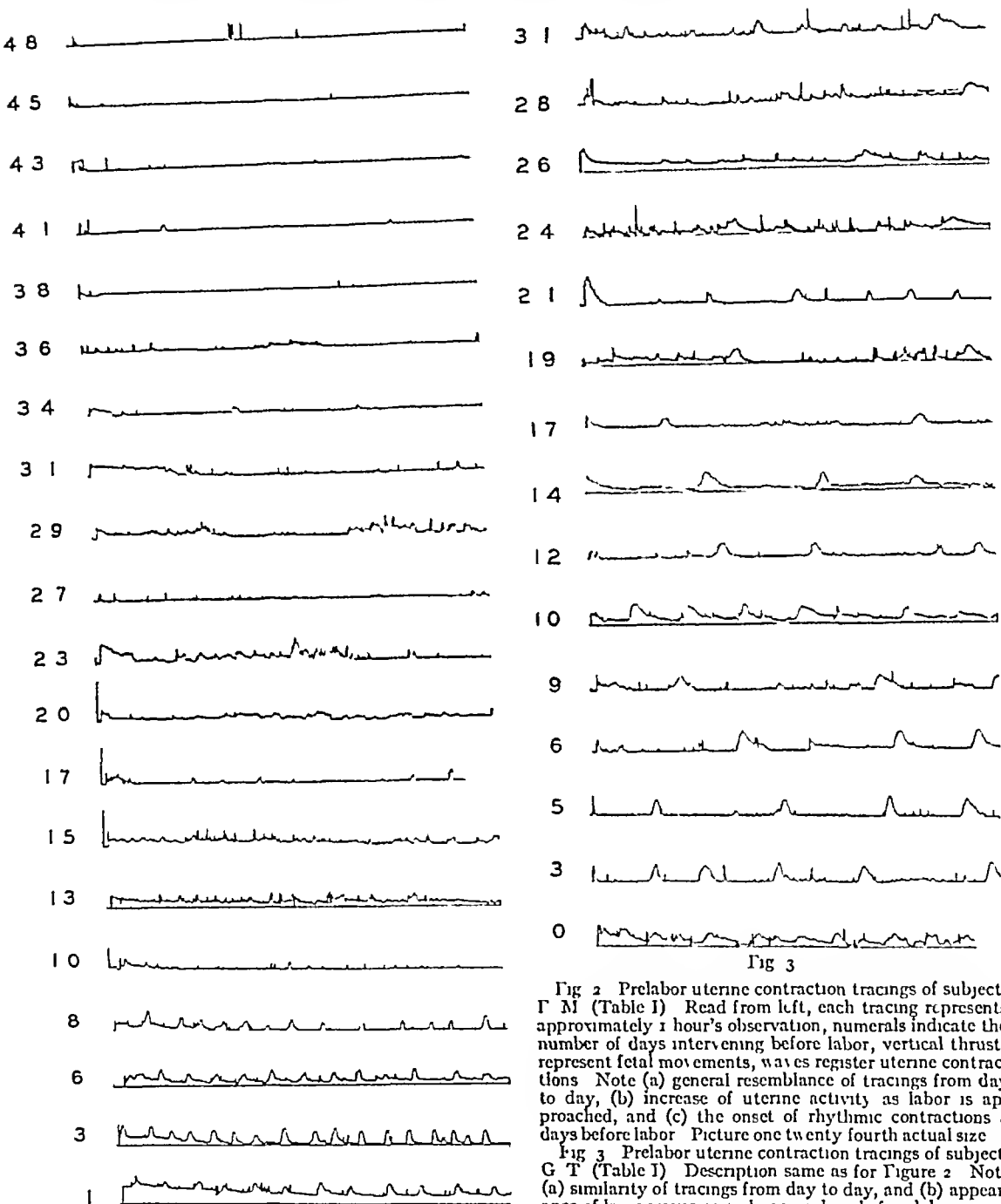


Fig 2

General character of tracings The general appearance of the tracings is exemplified by

Fig 2 Prelabor uterine contraction tracings of subject, Γ M (Table I) Read from left, each tracing represents approximately 1 hour's observation, numerals indicate the number of days intervening before labor, vertical thrusts represent fetal movements, waves register uterine contractions Note (a) general resemblance of tracings from day to day, (b) increase of uterine activity as labor is approached, and (c) the onset of rhythmic contractions 8 days before labor Picture one twenty fourth actual size

Fig 3 Prelabor uterine contraction tracings of subject, G T (Table I) Description same as for Figure 2 Note (a) similarity of tracings from day to day, and (b) appearance of large waves as early as 31 days before labor

those of patients F M and G T reproduced in Figures 2 and 3 The numerals at the left indicate the number of days between the re-

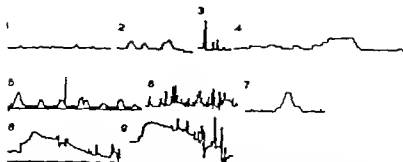


Fig. 4. Uterine contraction waves of subject, M. R. and . very small and large waves, forty-ninth day before labor; 3, fetal movement, forty-fifth day; 4, large wave showing step formation, thirtieth day; 5, large waves with strong fetal movement, twenty-third day; 6, active fetal movement sixteenth day; 7, symmetrical step formation, tenth day; 8, strong tetanic contractions with prolongation of fall of wave, seventh day; 9, same as 8 but with even greater tetanic tension between waves, 1 valley level at start of wave well above base line.

confiling of the tracings and the onset of labor. The sharp thrusts due to fetal movement are readily distinguishable from the slower waves which are the result of uterine contractions.

Patient F M (Fig 2) exhibited little uterine activity until 8 days before labor when her uterine waves became very rhythmic in appearance.

Patient G T (Fig 3) on the other hand, showed a considerable degree of uterine activity as early as 31 days before labor.

Each of the 5 patients exhibited a distinctive contraction pattern. The similarity in the appearance of the various tracings of any one patient, and the dissimilarity between the patterns of different persons, represent 2 of the most significant observations arising from the present study.

General characteristics of the uterine contractions. In a general way the waves created by uterine contractions can be classified in 3 categories, depending upon the duration of

pregnancy at the time that they are recorded (a) waves registered before the fortieth week of pregnancy and (b) those recorded during the fortieth week.

Contractions registered before the fortieth week. Waves observed at this time were characterized primarily by arrhythmia, and by variations both in shape and magnitude (Fig 4). Two sizes of waves were observed, large and small.

The small waves were seen only in the period before the fortieth week. They were more numerous than the large ones, more uniform in size and shape and had a tendency to occur in groups. In many cases these small waves immediately preceded a large wave (Fig 5). The small waves shown in the latter figure were usually associated with what the patient described as a "rolling" sensation.

The large waves were much less frequent than the small waves and came at more irregular intervals. They were greater in all dimensions than the small waves, and had a strong tendency to rise and fall in "steps" (Fig 4, tracings 4 and 7) the latter being variable in number, position, height, and breadth.

Contractions recorded during the fortieth week. About the beginning of the last week of pregnancy a change in the wave picture was usually observed. This is demonstrated in the eighth day tracing shown in Figure 2. At this time the so called large waves of the earlier period increased in frequency and height, became more uniform in size and took place



Fig. 5. Prelabor tetanic contraction tracings of subject, S T (Table I). Description same as for Figure 4. Note series of small waves, uniform in height, duration, and occurring at regular intervals, immediately preceding large wave. With these small waves the patient experienced "rolling" sensation. The small waves are about one-fifth in height, and therefore represent changes in the abdominal wall contour of only one-seventh of that amount.

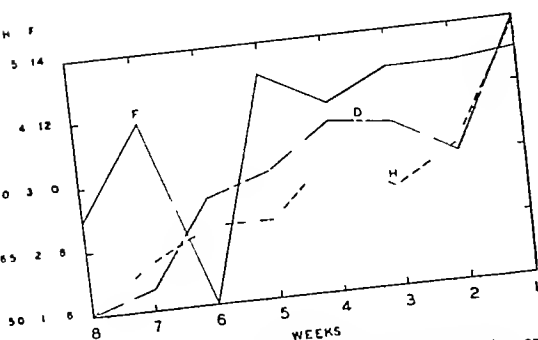


Fig 6 Base line represents weeks intervening between recording of contractions and onset of labor. Vertical line records average values for duration, *D*, height, *H*, and frequency, *F*, of uterine contraction waves, data taken from Table II. Note increase in all measurements as labor is approached and the unusual increase in the height and duration of the waves during the week immediately preceding labor.

at more regular intervals. The rise and fall of these waves usually were equal in duration, but there was a tendency for the fall to be longer than the rise (Fig 4). In some cases the fall lasted several minutes.

MEASUREMENTS OF CONTRACTIONS

Each of the 1,377 uterine contraction waves was measured, a summary of which appears in Tables I and II. The first table lists the average values of these measurements by patients, the second table groups these contractions according to the number of days which elapsed between the recording and the onset of labor.

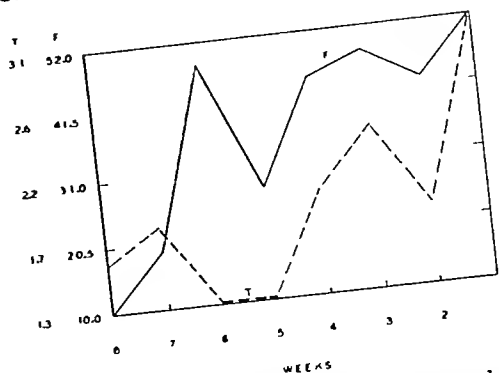


Fig 7 Base line represents weeks intervening between recording of contractions and onset of labor. Vertical line records the percentage of uterine contractions felt by patient, *F*, and the average distance of tracing from base line (tension of uterus), *T*, data taken from Table II. Note the unusual increase in tension during the week immediately before the onset of labor.

MEASUREMENTS OF CONTRACTIONS BY PATIENTS

Frequency Of the 106 daily tracings, 2 failed to record any uterine activity, these 2 records were obtained from the same patient, 1 during the sixth week and 1 in the seventh week prior to labor. The average frequency of contractions for the 5 women (Table I) was 111 ± 60 per hour, with a coefficient of variation of 540, and a range between 1 and 38 hours.

Strength The strength of contraction can be measured best as the height of the wave, though the relationship between the two is not known. However, the height of the wave

TABLE I—UTERINE CONTRACTIONS INDEPENDENT OF INTERVAL BEFORE LABOR¹

of labor

TABLE I —UTERINE CONTRACTIONS INDEPENDENT OF INTERVAL BEFORE

Patient	Daily records	Observation time hrs min	Contractions												Interval				Tension mm.
			Recorded	Felt %	Frequency			Strength			Duration			Total	Weight mean sec.	Maximum sec.	Minimum sec.		
					Weight mean p/hour	Maximum p/hour	Minimum p/hr	Weight mean mm	Maximum mm	Minimum mm	Weight mean sec.	Maximum sec.	Minimum sec.						
M R	35	41 8	396	43	10 3±5 5	13	6	3 5±2 0	13 0	0 3	110±57	714	6	360	209±159	1272	24	1 8	
S T	9	32 40	497	14	14 4±9 2	38	1	1 4±1 7	12 8	0 1	54±45	636	1	468	183±145	1847	6	4 1	
H V	20	22 04	208	73	9 1±5 5	21	0	4 1±2 0	14 2	0 2	93±61	684	12	190	260±128	1770	42	1 2	
G T	14	15 16	194	55	12 9±5 5	30	6	4 1±3 3	18 0	0 2	104±88	660	4	185	240±175	1212	24	0 7	
M C.	9	8 46	82	54	10 1±4 5	15	1	3 2±2 2	16 2	0 2	66±55	194	2	87	233±173	1165	25	1 0	

¹ Recording the averages for all measurements of the uterine tracings of five individuals. Felt contractions refer to those of which the patient was conscious. Tension refers to the distance of the valley level above the base line. Note the large standard deviation and the wide range between minimum and maximum figures for all characteristics.

¹ Recording the averages for all measurements of the uterine tracings of five individuals. Felt contractions refer to those of which the patient was conscious. Tension refers to the distance of the valley level above the base line. Note the large standard deviation and the wide range between minimum and maximum figures for all characteristics.

TABLE II.—CONTRACTIONS IN RELATION TO ONSET OF LABOR

Days before labor	Percent recorded	Daily records	Duration of observations in min.	Contractions						Tension mm.
				Recorded	Felt per cent	Frequency per hr	Weighted mean			
							Height mm.	Duration sec.	Interval sec.	
30-35 sec.				42	90	8	60-66	30-36	54-130	6
45-50 sec.	3	24	47	18	30	2	7-10	35-44	45-56	1
35-45 sec.	3		24 27	63	45	6	4-5	40-49	30-51	173
45-55 sec.			24 27	136	65	13	4-5	39-46	45-56	14
45-55 sec.			24 27	173	64		4-5	39-46	45-56	107
4-11 sec.		14	5 14	197	49	2	3-4	37-45	47-53	130
8-14 sec.		17	10 16	83	64		3-4	36-44	47-53	13
7 sec.	5	28	20 28	50	52	2	4-5-2-3	39-46	47-53	2

*According to the vertical line all measurements of the various contractions of the five individuals listed in Table I were grouped according to the interval in days between the recording and the onset of labor. Note the increase in the measurements as labor was approached.

was found to be in proportion to the strength of the associated subjective sensation and to the tenseness of the uterus. The height of the average wave was 3.2 ± 1.2 millimeters, with a coefficient of variation of .668 and a range varying between .2 millimeter and 16.2 millimeters.

Duration. The duration of the average wave was 85 ± 61 seconds, with a coefficient of variation of .716 and a range between 1 second and 21 minutes and 54 seconds.

Interval. The average interval from the start of one wave to the beginning of the next was 243 ± 156 seconds with a coefficient of variation of .642 and a range between 6 seconds and 30 minutes and 47 seconds.

Contractions felt by patients. The 5 patients were conscious on the average of only 47 per cent of the recorded contractions. This figure included both the very small as well as the large contractions. One woman felt only 14 per cent, while another was conscious of about 73 per cent.

MEASUREMENTS OF CONTRACTIONS IN RELATION TO THE ONSET OF LABOR

There was a progressive increase in uterine activity as labor approached (Table II, Figs. 6 and 7) with an unusual increase during the last week or 10 days of pregnancy. The latter increase in the number of contractions occurred before there was any clinical evidence that labor had begun.

Contractions felt by patients. Contractions were felt by the patients as early as 56 days before labor (Table II) the proportion, however, was relatively small until the forty-second day. As labor approached there was a progressive increase in the number of contractions felt (Table II and Fig. 7). This increase was greatest during the last week of pregnancy but was not in proportion to the increases in the measurements of the contractions.

Tension of uterus. The mean level of the valleys between the uterine contraction waves varied in the different individuals. When the abdominal wall was soft, the level of the valleys coincided with the base line. When tense, it remained above the line. The average distance from base line to valley level was secured by taking measurements at 5 minute intervals on each tracing, the result being recorded in millimeters (Tables I and II, and Fig. 7). The tension varied from day to day but in general increased as labor was approached. It was highest the week before labor.

SUMMARY AND CONCLUSIONS

1. The uterine contractions of 5 women, each pregnant for the first time, were registered by means of a Lördin tocograph at intervals of several days throughout the last 2 months of pregnancy.

2. One hundred six records each representing at least one hour's observation and total-

ling 120 hours of recording, gave 1,377 uterine contraction waves for measurement and comparison

3 The general character of the uterine contractions in a given patient tended to follow the same pattern from day to day

4 The contraction patterns of the patients differed widely in their various characteristics

5 The average frequency of contractions was 11 ± 6 per hour, with a range from 0 to 38 per hour

6 The height of the average wave produced by a uterine contraction was 3.2 ± 2.2 millimeters, with a range from 0.1 to 16.2 millimeters

7 The average duration of the contractions was 85 ± 61 seconds, with a range between 1 second and 11 minutes and 54 seconds

8 The average interval from the start of one contraction to the beginning of the next was 243 ± 156 seconds, with a range between 6 seconds and 30 minutes and 47 seconds

9 The patients were conscious of approximately 47 per cent of recorded contractions, one subject felt only 14 per cent, and another experienced 73 per cent

10 As labor approached progressive increases were observed in the measurements of the following characteristics of uterine motility (a) the strength, duration, and frequency of uterine contraction, (b) the percentage of contractions which were felt by the patient, and (c) the tension of the uterus. An unusual increase in the measurements of each of these qualities with the exception of

"frequency" was observed during the week or 10 days immediately preceding the onset of labor

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ENDOMETRIOSIS OF THE SIGMOID RECTOSIGMOID AND RECTUM

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FIRST described as an entity by von Rokitansky in 1860 endometrioma, or adenomyoma, has remained an enigma which invites investigation because of its pathological and physiological features. In general, an endometrioma may be considered a tumor composed of aberrant endometrial cells associated with smooth muscle cells in some situations. The condition is found in the vast majority of cases at some period between the onset and the cessation of the menstrual function, and the epithelium undergoes the same physiological response to the action of ovarian hormones as does the normal mucosa of the uterus.

The lesion has been found in the form of a single tumor or formations of multiple tumors or dense infiltrations in a number of different situations including the sigmoid flexure of the colon, the rectovaginal septum, and the rectum. The practical importance of differentiation of such tumors from carcinoma and the inflammatory conditions of the bowel is easily realized. Endometriosis of the lower portion of the intestinal tract occurs somewhat more frequently than is commonly supposed. Sampson (6-10) found 13 intestinal implants in 64 cases. In one instance, the small intestine and sigmoid flexure were involved in another the cecum was involved. In the remainder the rectosigmoid. Polster in a collective review reported 80 cases involving the bowel and 90 cases involving the rectovaginal septum.

Known considerations which are offered to help in arriving at a correct differentiation when the bowel is involved, are these: (1) endometriomas occur in females, usually between the age of 30 years and the menopause (2) the longer the duration of the condition the greater the chance is that a non-malignant lesion exists (3) the general health of the patient is better

and loss of weight does not occur so frequently when an endometrioma is present as when some other malignant lesion is present, (4) dysmenorrhea is a common complaint (5) symptoms may have a definite rhythm, being present only at, or accentuated during, the menstrual period, whereas carcinoma and inflammatory conditions produce no such periodic symptoms (6) sterility is often present (7) slight to marked constipation with periodic accentuation, is often one of the prime complaints, and this may progress to a more or less complete intestinal obstruction according to the severity of the condition. Sampson's (6) patient suffered from constipation which gradually increased in severity for a period of 2 years, and attacks were most severe at the menstrual period; the abdomen became distended and nausea and vomiting were present (8) diarrhea is less frequently observed but Collen refers to a patient who had diarrhea concomitant with the beginning of her menstrual period, and who later suffered from pain in the lower part of the bowel 24 hours before the onset of menstruation and who experienced melena (9) occult or fresh blood in the stools is more common in the malignant than in the benign states, and in some cases of endometrioma, bleeding was present only during menstruation being infrequent, however since endometriosis rarely involves the mucosa of the lower bowel (10) pain on defecation is frequently present when an adenomyoma of the rectovaginal septum projects into the lumen of the rectosigmoid or the rectum and this pain may be present only during menstruation (11) results of proctoscopic examination are either negative or reveal a mass which is not primary in the wall of the bowel, pushing into it from without. If a tumor is seen, biopsy often will aid in the diagnosis (12) roentgenographic investigation may help, in that the filling defects caused by endometriomas may be difficult to diagnose since they

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exhibit nothing distinctive, whereas carcinoma or the inflammatory states may produce a clear-cut picture

However, the symptoms and signs presented in any individual case may vary considerably from the aforementioned pattern. At times a diagnosis cannot be made, even when the abdomen is surgically explored and the involved segment of bowel is brought into the wound. The gross resemblance of an endometrioma of the sigmoid flexure to a scirrhus carcinoma in an early state of development is at times remarkable. The peritoneal surface may be puckered and scarred in the presence of both conditions. When endometrioma is present, the stricture usually does not encircle the bowel completely, and the tumor can be lifted up from the wall of the bowel. The regional lymph nodes may be involved and enlarged if malignancy is present. However, the final decision may often rest with the pathologist after the tumor has been removed.

Thirty-eight cases of endometriosis of the sigmoid, rectosigmoid, and rectum in which the patients were encountered at The Mayo Clinic comprise the series under consideration. Five of these cases have been reported elsewhere, 1 by Mahle and MacCarty and 4 by Judd and Foulds. In 13 cases of this series, the lesions were situated in the sigmoid alone, while in 3 cases there were solitary endometriomas situated in the rectosigmoid. In the remainder of the cases, there was involvement of the various structures of the pelvis in addition to different portions of the lower part of the bowel. In many cases, the rectovaginal septum and the contiguous portion of bowel were involved. The ages of the patients represented in the series had a range approximating the menstrual life of the female, and extended from 25 to 54 years, the average being 38 1 years. Eighty-seven per cent of the patients represented in this group were between the ages of 30 and 49 years.

Pertinent data of this group are: 28 of the patients were married and 10 were unmarried. The total duration of the symptoms ranged from a low of 2 months to an extreme of 27 years. Twelve patients became pregnant, 23 had periodicity of symptoms. Eighteen patients had dysmenorrhea, 28 had abdominal

pain, 20 had constipation, 3 had diarrhea, 11 had rectal pain, 11 had blood in the stools, and 6 had loss of weight.

The duration of endometriosis before the patient is seen by the physician often is much longer than that of carcinoma. The greater number of patients of this series said that they had experienced symptoms for from 2 to 5 years. As might be suspected, a sterility of relative stubbornness often is associated with endometriosis. The large number of patients in this series who became pregnant may be attributable to either one of two factors: (1) some of these patients had had their children before the onset of the disease, and (2) others had their lesions in isolated situations wherein there could be no interference with the reproductive organs. Six of the patients who complained of rectal pain had lesions in the rectovaginal septum. Loss of weight usually was associated with some disease other than endometriosis. Only 6 of the 38 patients reported such a reduction in weight.

Much reliance should be placed on an accurate, detailed history, because the physical findings of endometriosis of the sigmoid and rectosigmoid often are not of much help. Inspection and palpation of the pelvic region, however, will aid materially in diagnosis of lesions in the rectovaginal septum. Fixation of the pelvic organs may be noted on bimanual examination.

It should be noted that but 9 patients of the entire group showed a significant decrease in the concentration of hemoglobin in the blood. In this connection, it may be stated that some of the 9 patients had other pathological conditions to account for the loss of blood. It is interesting also that 2 patients had undergone colostomy for intestinal obstruction, 1 having had the operation 5 years, and the other 9 months, before coming to the clinic, where additional surgical treatment was provided.

Proctoscopic examination was performed for 18 patients and normal findings were reported for only 3 of these. Narrowing of the lumen of the bowel, projection of a mass into the bowel, or of a tumor outside the wall, were encountered in the remainder of the patients for whom proctoscopy was performed, except 1 patient in the examination of whom a definite carci-

noma of the rectum was visualized. Since there are no roentgenographic peculiarities for endometrioma of the bowel, the reports describing the condition of these patients stated either that the bowel was normal or that a stricture was present. Stricture, however is not a characteristic filling defect. The differentiation between malignant and inflammatory conditions is extremely difficult at times in this region of the body.

It is also to be noted that some of the endometriomas in this series had not necessarily produced symptoms. A number were encountered and recognized during the course of pelvic operations for other diseases. When the lesion was recognized as an adenomyoma and was solitary it was either untouched or removed, depending on the state of the bowel, the coexisting pathological condition in the remainder of the pelvic organs, and whether or not the ovaries were to be removed. When the endometrioma was not removed, a note was made that if subsequent difficulty should arise, recourse might be had to either roentgen-rays or radium therapy. In addition other pathological changes in the bowel must be searched for as is illustrated by one patient who had an endometrioma in the sigmoid and a carcinoma of the rectum.

Thirty-one patients were treated conservatively and 7 radically. Treatment of the group as a whole was predominantly conservative and this trend has been rather definite in recent years. However when radical intervention was deemed absolutely necessary it was done. As has been pointed out, the diagnosis of endometriosis so often is in doubt up to and sometimes during surgical exploration that a definite rule as to the exact course of treatment cannot be laid down. When the lesion looks and feels like a malignant lesion, when metastasis cannot be found, and when evidence of the presence of endometriosis cannot be found in the pelvis, conservative resection of the bowel is the procedure of choice, especially if the patient is young and is desirous of having children. The desirability of preservation of the ability to conceive often may decide the course to be followed.

In the treatment of an older patient near the menopause concerning whom the question

of future childbearing may be dimmed, roentgen-rays or radium implantations offer the possibility of the induction of an artificial menopause which will completely alleviate the symptoms and correct the existing pathologic condition. If obstruction exists, a temporary colonic stoma may be made and roentgen-ray or radium treatment may be given, in which an amount of irradiation sufficient to produce permanent inhibition of the ovarian function may be administered. This measure will remove cyclic stimulation of the ovarian hormones to the endometrium. Regression of the latter will then occur. However conservative therapy both in respect to preservation of the ovaries and operative procedure on the bowel, should be paramount.

Thirty-two patients in this series are living and well at the present writing. Four have lived 10 or more years since operation, 5 from 5 to 10 years, 16 from 1 to 4 years, and 7 for less than 1 year. There was but 1 death in the hospital for this entire series. The condition of patients was followed for varying lengths of time after they left the clinic and only 2 have been reported as having died. One of these patients was found at operation to have had carcinoma of the ovary in addition to endometrioma of the sigmoid and she died about 6 months after operation. The second of these patients underwent an operation elsewhere for an unknown condition and succumbed. The final condition of 3 patients could not be ascertained.

SUMMARY AND CONCLUSIONS

1. Eighty-seven per cent of the patients having endometriosis were between the ages of 30 and 49 years.
2. Symptoms attendant upon endometriosis usually are present for a longer period than those commonly associated with carcinoma or inflammatory conditions.
3. The patients are relatively sterile.
4. The presence of symptoms which are periodic in nature, such as constipation, diarrhea, rectal bleeding, or rectal pain should suggest the presence of endometrioma.
5. Dysmenorrhea is often present.
6. Discomfort in the lower portion of the abdomen is a common complaint.

7 The general health of the patient is usually good

8 Proctoscopic examination and roentgenographic investigation do not result in characteristic findings

9 The diagnosis is always difficult and the symptoms vary considerably

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LUDWIG'S ANGINA

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LUDWIG'S angina has been regarded as an entity by most authorities since Ludwig's classical description in 1836. Thomas, in 1908, reiterated this description and offered a practical surgical approach based on careful anatomical and pathological investigation. The mortality in Ludwig's 5 cases was 60 per cent. Thomas in a series of 106 cases, reported a mortality of 40 per cent and prophesied a further reduction through better understanding and treatment of this type of infection.

But in a group of 31 recent cases, collected from several local hospitals (Table I) the mortality was 54 per cent. Such a rate, nearly as high as that reported by Ludwig a hundred years ago suggests that knowledge of the advances made since his time is not general and that in most cases this disease still does not receive proper recognition and treatment.

In the American literature emphasis has been placed on the anatomy and the pathology of Ludwig's angina and, to some extent, on the surgical approach. The clinical aspects, which have received somewhat meager attention previously will be stressed in this paper. A proved surgical approach will be described in detail. The rôle of tracheotomy, the choice of anesthesia and the use of certain drugs will be accorded the importance they deserve. The viewpoints presented have grown from clinical observation, a study of the 31 cases here mentioned and a consideration of the literature.

This condition is not rare. 8 such patients having been admitted to the Boston City Hospital during the last 15 months.

ANATOMY

The clinical features peculiar to Ludwig's angina are due to an infection involving the tissues of both the submaxillary and sublingual spaces. Clinical manifestations of infection in both these regions are prerequisite to a diagnosis. Other spaces may or may not

be involved. This conception is in agreement with Ludwig's description and with the consensus among those who have studied the disease since his time.

A thorough knowledge of the regional anatomy is essential to an adequate diagnostic and surgical approach. The key lies in the unyielding deep cervical fascia (Fig. 1). This fascia is fixed to the inferior border of the mandible from which it sweeps downward and inward to become attached to the hyoid bone, thus separating the suprathyroid region from the lower neck. Within the suprathyroid region this fascia is attached to the anterior and posterior bellies of the digastric muscle, thus delimiting the submaxillary and submental areas (Fig. 1). The structure possibly second in importance is the mylohyoid diaphragm formed by the two mylohyoid muscles which from their attachments to the mandible, pass downward and inward to be inserted along the hyoid bone posteriorly while they fuse with one another anteriorly to form a median raphe (Fig. 2). Below the mylohyoid diaphragm anteriorly and between it and the deep fascia, lies the triangular submental space, further bounded by the anterior bellies of the digastric muscles laterally and the hyoid bone inferiorly. Above the mylohyoid diaphragm lie the two sublingual spaces which are bounded laterally by the body of the mandible, above by the mucous membrane of the floor of the mouth and medially by a muscular raphe which is deficient anteriorly allowing for communication of one sublingual space with its fellow of the opposite side (Figs. 2 and 4). The submaxillary gland lies at the posterior border of the mylohyoid muscle, resting partly in the submaxillary and partly in the sublingual spaces, permitting an avenue of communication between the two. The submaxillary space has potential communication, deep to the hyoid bone with the lower neck (2). It also has potential communication with the parapharyngeal or lateral pharyngeal space by

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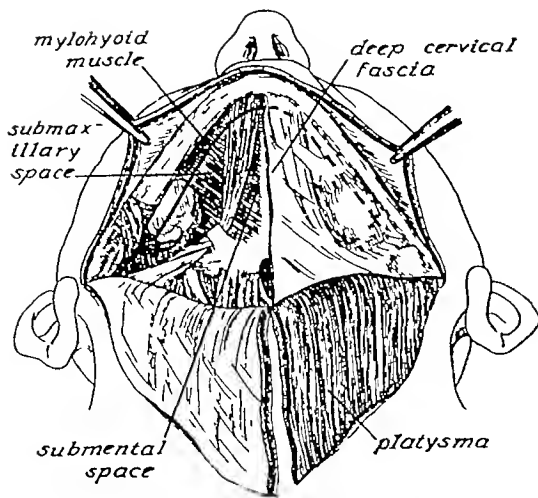


Fig 1 Right, the skin and platysma have been reflected to show the deep fascia. Left, the skin, platysma, and deep fascia have been reflected to show the submaxillary and submental spaces. The solid line indicates the site of incision for unilateral infections. The dotted line indicates its extension in bilateral infections.

way of the stylohyoid sheath and the glossopharyngeal nerve (37).

The mylohyoid diaphragm prevents downward expansion of the sublingual space. The strong fascial attachments further close all these spaces from superficial expansion or communication.

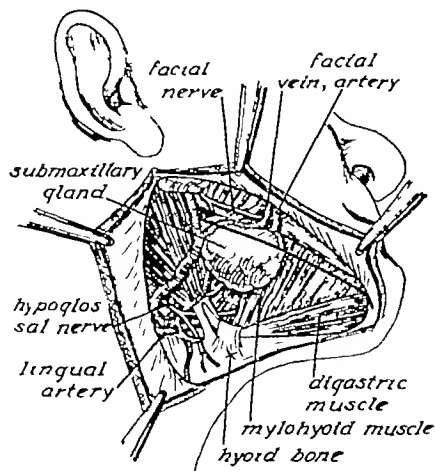


Fig 3 The skin, platysma and deep fascia have been reflected. The relation of the incision to vital structures is shown. Only the facial vessels must be divided. The submaxillary gland may be reflected, incised or excised.

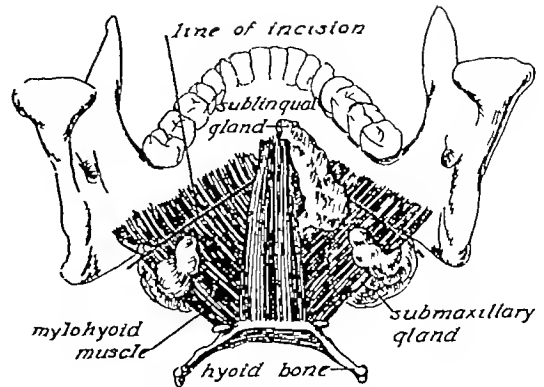


Fig 2 The mylohyoid diaphragm as seen from above, indicating where it should be divided by incision from below. The sublingual spaces communicate about the anterior tip of the sublingual glands. Several structures have been omitted to allow visualization of the diaphragm. The sublingual gland is shown only on the right.

ETIOLOGY AND PATHOGENESIS

Streptococci, predominantly of the hemolytic group, are the causative organisms in most cases of Ludwig's angina, occurring alone, often with the staphylococcus or occasionally with the pneumococcus. Streptococci were present in 72 per cent of the cases in which culture reports were available. Others have reported a similar figure (4, 12, 31, 35). Staphylococci or pneumococci may be the only organisms noted. Recently (27, 28, 29) attention has been called to the frequency of secondary infection with anaerobic organisms.

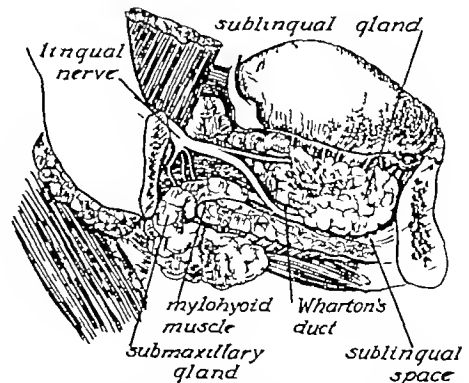


Fig 4 The submaxillary gland lies at the posterior border of the mylohyoid muscle. The deep portion, with Wharton's duct, extends into the sublingual space while the bulk of the gland lies more superficial in the submaxillary space. The tongue and mucous membrane of the floor of the mouth are evident.

TABLE I.—SUMMARY OF 3 CASES

Patient, age	Hospital†	Culture report	Anesthesia	Tracheostomy	Bacterial culture (postoperative)	Spontaneous drainage	Result
M L 41	M O H.	<i>Streptococcus hemolyticus</i> , <i>Staphylococcus albus</i>	Kovacs	Pre-operative	+		Dead
T M 30	M O H.	<i>Streptococcus hemolyticus</i>	No surgery	None	+	+	Recovered
T D 34	M O H.	Hemolytic <i>staphylococcus</i>	No surgery	None		+	Recovered
M P 45	M O H.		Ether	During operation			Dead
E M	M O H.			None		+	Recovered
M M 33	M O H.	<i>Staphylococcus</i>		Postoperative			Dead
A D	M O H.		Kovacs, N ₂ O	None			Recovered
L G 43	M O H.	<i>Streptococcus hemolyticus</i>	Ergal	None			Recovered
E S 46	P B B H.	Non-hemolytic streptococcus	Avertin	None			Dead
E S 33	M H.	<i>Pseudomonas</i> XIX	N ₂ O, O ₂	During operation			Dead
D D 66	M H.		Ergal	None	+		Dead
W R, 76	B C H.	<i>Streptococcus hemolyticus</i> , <i>Streptococcus viridans</i> , <i>Staphylococcus aureus</i>	Cyclopropane	During operation	+		Dead
M M 63	B C H.		No surgery	None		+	Recovered
M M	B C H.	<i>Streptococcus hemolyticus</i>		None			Dead
W S 3	B C H.		Cyclopropane	None	+		Recovered
M G 36	B C H.	<i>Streptococcus viridans</i> , <i>Micrococcus catenulatus</i>	N ₂ O, O ₂	None			Recovered
G R 36	B C H.	<i>Streptococcus hemolyticus</i>	Penicillin	None	+		Dead
V A 35	B C H.	<i>Staphylococcus albus</i> , <i>Pseudomonas</i> VIII	N ₂ O, O ₂	During operation			Recovered
M P 45	B C H.		No surgery	None			Dead
T F	B C H.		Ether	None	+		Dead
R V 36	B C H.		N ₂ O, O ₂	Postoperative			Dead
N B 46	B C H.	<i>Streptococcus hemolyticus</i> , <i>Staphylococcus aureus</i>	Kovacs	None			Dead
E L 33	B C H.	<i>Staphylococcus albus</i>		None			Recovered
J L 36	B C H.	<i>Streptococcus hemolyticus</i> , <i>Staphylococcus albus</i> , <i>Staphylococcus aureus</i> , <i>Vibrio</i> ?	N ₂ O, O ₂	None		+	Recovered
C H 44	B C H.	<i>Staphylococcus albus</i> , <i>Streptococcus viridans</i>	Penicillin	None		+	Recovered
J C	B C H.		N ₂ O, O	None	+		Recovered
L B 62	B C H.		N ₂ O, O	None			Dead
B C	B C H.		N ₂ O, O	Attempted**			Dead
J C	B C H.		Cyclopropane	None	+		Dead
W M 36	B C H.	<i>Streptococcus hemolyticus</i>	Penicillin	During operation	+		Recovered
W R 46	A H.	Non-hemolytic streptococcus	Penicillin	None			Dead

*Information lacking

**Dead of sepsis under anesthesia

M O H.—Massachusetts General Hospital

P B B H.—Peter Bent Brigham Hospital

M H.—Milton Hospital

C H.—Boston City Hospital

N H.—Newton Hospital

and to the synergistic effect they exert. Spirochetes, spirilla, fusiform bacilli, anaerobic streptococci and *Clostridium welchii* are often present. Too commonly anaerobes are not sought for by special methods and are consequently not reported.

The portal of entry of infection may be a lesion anywhere about the lower lip, tongue, floor of the mouth, gums and teeth of the lower jaw, tonsils or pharynx (35). Calculi in the submaxillary gland or duct have been mentioned as a cause (6). Infections incurred about the lower molars, particularly following extractions, are the common source, constituting the initial episode in 51 per cent of the cases of this series. This has also been the experience of others (2, 12, 15, 32, 33).

The manner of development of the infection has been the subject of several investigations (2, 16, 35, 37). Whether the spread is via lymphatics or by contiguity of tissues matters little. However, it is of practical importance to recognize that, regardless of whether the submaxillary or sublingual space is first involved, since one communicates with the other, both will shortly partake in the process. The resulting pathological picture is that of a diffuse, edematous, and rapidly spreading cellulitis beneath the deep cervical fascia and involving these two spaces.

Pus in considerable quantities is a late development. When the swelling is incised, one encounters only a porky edema with perhaps a streak of thin watery pus here and there. Because pus is scanty and lies beneath the deep fascia, fluctuation should not be expected. It was absent in 94 per cent of the cases in this series.

Due to the restraining deep cervical fascia and mylohyoid muscles, expansion of the submaxillary and sublingual tissues is upward and posterior at the expense of the oral and pharyngeal cavities. This swelling often assumes literally immense proportions. The tension thus created by a fulminating infection so confined accounts in part for the necrosis of the deep tissues noted so constantly at necropsy. The impingement on surrounding structures which results gives rise to dysphagia, dysphonia, and respiratory embarrassment.

Spontaneous rupture into the mouth or throat occurs, having taken place in 19 per cent, or 6 cases, of this series. All of these patients recovered, though 2 required operative drainage as well. This eventuality is not favorably stressed since delay, with the hope for some such happy outcome, only tends to minimize the chance of successful intervention. It should be remembered that in 81 per cent of the cases spontaneous rupture did not occur.

CLINICAL FEATURES AND DIAGNOSIS

Ludwig's angina has certain clinical characteristics. A massive swelling, often bilateral, always brawny and tender but rarely fluctuant, involves the suprahyoid region, being extreme in the submaxillary area. The overlying skin is conspicuously free of inflammation, showing only edema. Such external manifestations are an indication of infection in the submaxillary and probably in the submental space.

The floor of the mouth is raised, edematous, and brawny. The mucous membrane beneath the tongue is often ulcerated and dirty grayish white. The tongue is swollen, pushed upward, and may become so crowded by sublingual edema that, filling the available space in the mouth and pharynx, it is forced forward as well, its tip even protruding between the teeth anteriorly. The presence of these signs in the oral cavity is diagnostic of infection in the sublingual space. The patient experiences pain and difficulty on attempting to open his mouth. Deglutition and speech are trying and often impossible. As a rule, respiratory embarrassment is present, a vital feature, easily and often overlooked. Temperature, pulse, and respirations vary in this condition but usually all are moderately elevated.

It is felt that a case must follow the above description rather closely to permit a diagnosis of Ludwig's angina.

COMPLICATIONS

Most imminent, most rapid, and most insidious of the complications is respiratory obstruction which may be due to blockage of the airways by an elevated or edematous tongue. Or it may occur in the larynx, precipitated by

laryngeal edema (35) Irritable anesthetics introduce an element of spasm which may suddenly make a partial obstruction complete. Of the patients in this study 80 per cent had varying degrees of respiratory difficulty. Emergency tracheotomy was performed in 8 instances. Four patients on whom tracheotomy was not done died of asphyxia.

Bronchopneumonia complicated 25 per cent, or 8 cases in this series, 7 of which terminated fatally. It was a late complication the time of development averaging 8 days after the onset of the infection in the neck. Surgical drainage had been instituted in 7 of these patients but in every instance seems to have been too conservative so that an undrained focus remained. Such lingering infections invite pneumonia, which is shortly fatal though the suprathyoid infection may be clearing. Tracheotomy probably aids in preventing this complication. Certainly it plays a minor rôle as a cause, having been performed in only 3 of the patients who developed pneumonia.

Further spread of infection is dangerously common having occurred in 25 per cent, or 8 cases. In 7 of these surgery was delayed or conservative. Guided and confined by the deep cervical fascia, sepsis has several possible routes of extension. The process may invade the submental space. It may burrow downward deep to the hyoid bone into the lower neck to find its way along the carotid sheath and eventually into the anterior mediastinum (2). Or it may extend posteriorly probably along the stylohyoid sheath, into the parapharyngeal space possibly to involve the larynx (35-37). Of the 8 cases in which extension took place 7 were fatal.

Septicemia is less common but highly fatal. From 2 patients positive hemolytic streptococcus blood cultures were obtained. These patients died.

At necropsy Ludwig noted widespread suppurative gangrene of the tissues deep to the deep cervical fascia. He observed this process extending into the mediastinum and remarked on the presence of pneumonia. These patients had survived 10 to 12 days. A similar process, involving the deep spaces of the upper and lower neck was revealed at

necropsy in 2 cases of the present series. In one of these the mediastinum was invaded and there was bronchopneumonia. In both these cases surgery had been deferred until suppuration should appear. In a third case, in addition to bilateral bronchopneumonia, suppurative necrosis, chiefly about the base of the tongue was noted. A short, transverse, submental incision obviously had been incompetent in view of the location and extent of the infection present.

TREATMENT

The aims of treatment are to establish an airway to relieve tension to secure drainage, and to combat the infection through supplementary measures.

The most dependable means of securing an adequate airway is to perform tracheotomy. It has a negligible bearing on the occurrence of pneumonia. Since the tracheotomy incision is made below the cricoid cartilage away from the infected field it does not increase the danger of spread of infection. Five emergency tracheotomies were performed for acute respiratory obstruction with onset during anesthesia for operative procedures on the neck. These patients became apneic, or gasped became deeply cyanotic, and stopped breathing leaving no doubt that immediate tracheotomy was essential.

However indications are not so dramatic when obstruction develops on the ward. Its onset is insidious and is heralded by an elevation of the pitch and timbre of the sounds which may be described as crowing. Too great emphasis cannot be placed upon this diagnostic point which has recently been stressed by Cawthorne. Increase in rate and decrease in depth of respirations is noticeable. The use of the voluntary muscles of respiration and retraction of the intercostal spaces with inspiration are valuable signs. A mild, dusky cyanosis may be present but is by no means essential. These signs are indications for tracheotomy. The surgeon should not wait for the patient to complain of difficulty in breathing or for such signs as gagging or deep cyanosis. For these are more than indications for tracheotomy they are forebodings of sudden death.

A tracheotomy kit should be kept beside the patient at all times and a careful liaison be maintained between the ward and the surgeon to cover the necessity for prompt tracheotomy should the occasion arise. The latter should be done under local anesthesia.

At time of operation, if the patient reveals any signs of respiratory difficulty, the trachea may be exposed and this wound packed with vaseline gauze before the infected areas are incised. Then, if necessity arises, completing the tracheotomy requires only a moment.

When a case fulfils the criteria prerequisite to a diagnosis of Ludwig's angina, immediate surgical drainage is indicated. It is too common a viewpoint that localization and fluctuation should be awaited and regarded as indications for surgery. Fluctuation and pus will develop in about 50 per cent of the cases but only after a matter of days. While one waits, he is exposing his patient to the grave complications here mentioned.

Davis, writing on Ludwig's angina in 1906, emphasized the necessity for "fearless surgery." Since that date, Thomas, Leonardo, Van Wagenen and Costello, Colp, and Bailey (3) have echoed this point of view, advising surgical drainage according to or closely resembling the following procedure.

The incision should commence just below and slightly anterior to the angle of the jaw and run forward, parallel to and about 1 centimeter below the body of the mandible, until it reaches the midline anteriorly (Fig 5). If the infection is bilateral, the incision should extend continuously around to a similar point near the angle of the jaw on the opposite side, always close to the mandible. It should divide the deep cervical fascia, the mylohyoid diaphragm, and the anterior belly of the digastric muscle (Fig 1) penetrating upward to a depth that will allow an exploring finger to reach the base of the tongue and the mucous membrane of the floor of the mouth. Such an incision lays open the sublingual, submaxillary, and submental spaces. Equally important, it cuts the restraining fascia and mylohyoid diaphragm (Fig 2), allowing the tongue and edematous tissues above to descend, thus lessening tension and vastly improving the airway. This approach should



Fig 5 Showing a scar 1 year after operation. A bilateral continuous incision was made and tracheotomy prepared for but not performed. The dotted line indicates the preferable site of incision.

give immediately noticeable and increasingly apparent respiratory relief.

The wound should be left open and packed with iodoform gauze which is left in place from 12 to 24 hours. At the end of this interval all hemorrhagic oozing should have stopped. The pack should then be removed and warm wet dressings applied.

Bailey has used this incision in 4 cases during the past 2 years with no fatalities (5). In addition, he removed the submaxillary gland in 2 of these patients, a procedure which had previously been recommended by Colp and by Ramsdell and which greatly increases the exposure of the deeper tissues, facilitating drainage. This measure was not carried out in any of the 31 cases in the present series.

There are no important nerves along the course of the incision described and the only

large vessels which are encountered are the facial artery and vein. These are easily located as they wind up the lateral aspect of the posterior portion of the submaxillary gland and over the mandible (Fig. 3). These vessels should be isolated ligated and cut. The lingual nerve is deep to the mylohyoid muscle and near the midline so it need not be feared. The hypoglossal nerve and lingual vessels are safely below running along posterior to and a trifle above the hyoid bone. The carotid sheath is far posterior and below. A branch of the facial nerve loops down lateral to the mandible emerging in front of the parotid gland but it does not extend below the mandible and therefore is out of the operative field. Any injury to the salivary glands and muscular structures is inconsequential.

Mosher writing on infections of the neck, states that "cosmetic surgery and life-and-death surgery do not mix" a sound observation. However the cosmetic results following the incision described are surprisingly good, the scar being noticeable only when the head is thrown back (Fig. 5). Healing is rapid and the functional result satisfactory.

Mosher advocates a T-shaped incision over the submaxillary area as the ideal approach to all infections of the deep fascial spaces of the neck. Such an incision affords excellent exposure to all these spaces but seems chiefly applicable to infections which have invaded the posterior or lower spaces.

The choice of anesthesia warrants deliberation. Most writers have advised the use of local anesthesia (2, 11, 35, 37). However it has several disadvantages. Several writers (4) have observed that local infiltration sufficed for the superficial part of the operation but that some form of general anesthesia was essential when the deeper structures were incised. The patient was thus exposed to the hazards of two anesthetics. According to Tovell to secure anesthesia for submental and submaxillary operations, the usual neck block must be supplemented by the deep injection of 20 to 30 cubic centimeters of novocain into the operative site. Many are of the opinion that the injection of an anesthetic into infected tissues fosters the progress of the infection. Such an objection seems

founded in Ludwig's angina since one of the chief aims of treatment here is to decrease tension due to an edematous process. On the other hand local anesthesia has distinct advantages which are well known. Should it be selected for use pentobarbital sodium 15 to 3 grains, by mouth is suggested as pre-operative medication to forestall any possible reaction to novocain.

With few exceptions (12, 15) writers on Ludwig's angina have warned against the use of nitrous oxide and ether because of the high incidence of spastic respiratory obstruction or because they felt that these patients often could not survive general anesthesia. Of 11 patients to whom these agents were administered 3 had to be subjected to emergency tracheotomy during operation. A fourth died while tracheotomy was being performed. Cyclopropane was administered to 3 patients, 1 of whom had to have an emergency tracheotomy because of obstruction while a second showed signs of spastic obstruction which were visibly relieved by incision and drainage. Such experiences lend weight to the previous admonitions regarding inhalation anesthetics.

In the hands of some, endotracheal intubation (26, 34) might allow for exceptions to this statement. However at the Boston City Hospital, it has been found that intubation is often difficult or impossible because of distortion of the airway. Helium (7, 13) greatly extends the range of usefulness of inhalation anesthesia in cases of partial respiratory obstruction but it is not yet available in most hospitals.

cases is available in the American literature, however.

Through the efforts of several anesthetists connected with the Boston City Hospital pentothal was used in 4 and evipal in 2 cases of Ludwig's angina in this series. Two patients stopped breathing during the administration of pentothal but both survived. In one of these, respirations began after the injection of 1 ampul of metrazol and a brief interval of artificial respiration. Tracheotomy was required in the second patient who was under light anesthesia and went into spasm, partly voluntary, during the operative procedure. The diagnosis of Ludwig's angina was recognized only after operation so that the lack of preparation for the treatment of operative complications was nearly fatal. The operative course of the 4 remaining patients was uneventful.

Bailey (3), who strongly recommends evipal for Ludwig's angina has used this agent in his last 4 cases without any untoward respiratory complications (5). He uses the operative approach advocated here.

These experiences in anesthesia seem to indicate that intravenous barbiturates are the safest choice in this condition which is, at best, fraught with danger. Pentothal sodium is preferred. This is offered as a suggestion which future experience may or may not substantiate.

Its use must be restricted to those familiar with the administration of pentothal. Lundy (25) suggests that, if pentothal is used, a 2.5 per cent solution would be best and he recommends that oxygen be administered throughout the procedure. Atropine, 1/100 grain, should be administered before operation. Coramine, 3 cubic centimeters, should be mixed and injected with the barbiturate as a prophylactic against respiratory depression. Artificial respiration and repeated intravenous injections of metrazol, 2 cubic centimeters, or picrotoxin, 3 milligrams (8), are indicated in event of serious respiratory depression. The jaw must be supported, and preparation for emergency tracheotomy is essential. Even should respiratory cessation occur with pentothal, prompt emergency treatment gives a good prognosis.

Recent animal experiments reported by Weese, suggest that intravenous barbiturates may cause respiratory cessation in cases of sublingual phlegmon through an abnormal carotid sinus mechanism. He advises waiting 5 minutes after the induction before operating as such an interval would abolish this danger.

As an adjunct to surgery sulfanilamide deserves first consideration. Since the causative organism in about 61 per cent of the cases was the hemolytic streptococcus alone or with some other organism sulfanilamide is indicated in over half of these cases. It should be a rule to culture the wound, the floor of the mouth, or any related lesion in every case and to administer sulfanilamide only in cases yielding hemolytic streptococcus cultures, for its possible ill effects are not to be courted unnecessarily.

Sulfanilamide was administered in 10 cases but in only 2 of these was its administration accurate and the organism proved to be a hemolytic streptococcus. In 1 case spontaneous drainage near the base of the tongue occurred. Operation and tracheotomy were necessary in the other. Both recovered. Of the 8 remaining patients, several obviously benefited but sketchy administration of the drug or failure to take cultures prevents accurate reporting of these results.

Difficulty in swallowing often renders impossible the oral administration of sulfanilamide. Where the drug is indicated it should be given in maximum dosages (21) regardless, using protosil or sulfanilamide in solution (21) by hypodermoclysis if necessary, a perfectly satisfactory route of administration. Best results will be obtained if the drug is continued until healing is well advanced (20).

Finally, let it be clear, that in these severe infections, sulfanilamide is not advocated alone but only as an adjunct to surgical treatment. Temporizing at this stage is an unjustified assumption of responsibility.

In a recent editorial (1), it was stated that, because of its sulphur content, pentothal sodium should not be administered to patients under treatment with sulfanilamide. However, according to Long (22), this statement is based on theory and is not borne out by clinical experience.

Moist heat, applied locally both before and after operation is beneficial. A dressing impregnated with warm normal saline or Dakin's solution gently packed into the wound and supported generously by flaxseed poultice serves excellently. This should be changed every 2 hours.

Homans makes the following statement with reference to the use of cold: "Therefore it is almost inconceivable that it (cold) should have a favorable local action upon inflammatory conditions in which local heat and hyperemia are purposeful and useful physiologic responses. This statement is heartily concurred with and the use of cold applications in Ludwig's angina denied."

In view of the work of Meleney (27-28-29) and others it is probable that anaerobes are a potent factor in the virulence of these infections and that they are not recorded because usually only aerobic cultures are employed. Anaerobic cultures in such cases should be routine. Meleney (28) urges prompt and radical surgery that the tissues may be effectively oxygenated. In gangrenous or slowly healing wounds yielding positive anaerobic cultures, hydrogen peroxide irrigations (14) and zinc peroxide dressings (27-28-29) are definitely indicated. Dramatic improvement in the local and general condition will follow their use.

Parenteral fluids are often required since the oral intake may be interfered with through difficulty in swallowing.

SUMMARY AND CONCLUSIONS

Ludwig's angina is an infection involving the tissues of the submaxillary and sublingual regions and is characterized by a non-fluctuant brawny edema in these areas. Gross pus may appear late. Immediate surgical relief is indicated once the diagnosis is made. The deep cervical fascia and mylohyoid muscles must be widely incised. Pentothal sodium is recommended as a satisfactory anesthetic provided one has a thorough knowledge of its use. Tracheotomy is often life saving. Its indications may be overlooked. The streptococcus alone or with other organisms occurs in 72 per cent of the cases. Anaerobic organisms are often present. Sulfanila-

mide is of great value in cases with positive streptococcus hemolyticus cultures. Zinc peroxide is indicated when anaerobic organisms are present. The chief complication are respiratory obstruction, pneumonia, extension of sepsis and septicemia. All give a grave prognosis.

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THE FORMATION OF GANGLIA AND CYSTS OF THE MENISCI OF THE KNEE

Observations on the Golgi Apparatus

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THE methods of histological investigation which are usually applied to tissues removed at operation are the routine forms of staining and such others, in special cases, as can be applied to material kept in the ordinary and commonly used fixatives.

Although, in the face of a number of well known false prophecies that certain fields had been 'well reaped,' another such statement may be ill advised, it seems probable that there is little further to be discovered in commonly observed pathological conditions by the use of present apparatus and ordinary staining methods. That this is generally thought of normal tissues is shown by the increasing use of new methods by histologists. Techniques, however, which are relatively simple in a laboratory where material may be obtained at will and at suitable times become irksome and tedious, if not difficult, when applied to human tissues obtained at operation. Nevertheless such special methods of study must be applied to pathological conditions if advances are to be made in pathological histology. The advantages of their introduction have been abundantly demonstrated in the case of brain tumors. Not only do the results throw light on the pathological condition but often the abnormal conditions suggest explanations of normally occurring phenomena.

For some time the writer has put aside part of tissues removed from operation cases for special study and in appropriate cases for investigation of the Golgi apparatus. Despite the statement that the Golgi apparatus of the cells of synovial membrane had not been observed (10) this structure was found to be demonstrable readily in human tissues. This observation has been recorded (9)

From the Out Patient Service, Royal Melbourne Hospital.

The method used was Da Fano's cobalt nitrate-silver impregnation technique. In this method early fixation in the cobalt nitrate formalin mixture is essential. I have been able to obtain fair and even good results with thyroid gland and other tissues when fixation had been delayed for 2 and, in cold weather 3 hours. With synovial membrane cells, however, results can be obtained, in my experience, only after immediate fixation. The best preparations are obtained when the material is dropped into the fixative on the operating table.

The observations made on the Golgi apparatus of the cells in ganglia and cysts of the semilunar cartilages of the knee seemed to throw light on some of the problems of their development and therefore are discussed here.

HISTOLOGICAL CHARACTERISTICS

In the earliest stage of formation of ganglia there is a proliferation of cells in the wall of the joint or tendon sheath. These cells, at the same time, become spheroidal in shape and swollen and thus much larger than their neighbors. The abundant protoplasm contains vacuoles which, like those of ordinary synovial cells, contain material not easily stained. A mucinoid material also collects between the cells and separates them from each other.

These areas—there are multiple foci of cell activity—gradually enlarge both by involvement of other cells at the periphery and by increase in the amount of intercellular material in the region. Gradually so much material accumulates that relatively few or even no cells are to be found in the middle of the affected zone.

These various foci may coalesce and so if the ganglion be examined at an early stage it may be multicystic but at a late stage it

may show, unless the process is progressing at the periphery, but very few cavities or only one, perhaps irregular, cyst

The changes occurring in cysts of the menisci of the knee are strictly comparable with those seen in ganglia. Minor differences need not be discussed here.

The walls of the final cyst or cysts are lined with a modified connective tissue which is like that forming typical synovial membrane. It is assumed that the evidence for the connective tissue nature of the synovial lining is appreciated. A review of the literature or a study of sections of this tissue leaves no doubt concerning its morphology. Mention is made of it since some recent articles refer still to "endothelial" linings.

The sequence of events then is that, in certain areas, cells become enlarged and at the same time there is an accumulation of mucinoid material. When the active stimulus discontinues, the process ceases and the cells at the periphery become, or those which have been but slightly affected remain, spindle in form and the central material is thus surrounded by tissue which is of the synovial type.

The problem in the interpretation of these observations is whether the process is a degeneration or is the result of a remarkable cellular activity and secretion.

In order to decide this question the best criterion seemed to be the character of the cells which were found in the "degenerating" areas. Since the state of the protoplasm in minor degrees of change is not easy to determine, recourse was had to the cytological "organoids" which are known to be affected rapidly by adverse influences.

THE GOLGI APPARATUS

The Golgi apparatus of cells of synovial tissue has been more readily demonstrable in abnormal than in normal conditions. This is true even in cases in which the reticular material is not apparently greater in amount. Some experiments suggested that this was due to differences in hydrogen-ion concentration. However, in so far as the fixing solution is an un-buffered slightly acid solution, it is probably due to some more subtle factor.

Whatever may be the cause of differences in impregnation, care must be taken in making comparisons between the large cells of the ganglia and normal cells. Such comparisons should be made between the large cells and such others in the same section which are by ordinary histological criteria "normal." This also overcomes the difficulty of comparisons between tissues in which silver impregnation may be slightly different.

The Golgi apparatus of ordinary synovial cells is, in sections, a reticular structure varying somewhat in size and shape and also in its position in the cell, in general, it resembles that of a connective tissue cell but is decidedly more developed and prominent. When the cells are altered, as e.g. in mild forms of inflammation, the Golgi material is greater in amount and still more prominent. This prominence is apparently associated with a larger amount of secretion since it is most obvious in the larger (more voluminous) cells and in those nearer the surface, in addition the apparatus is related in position to vacuoles in the cells.

In ganglia extraordinary changes are to be observed. The cells which become swollen contain an extremely complex Golgi apparatus. It is difficult to obtain a complete idea of the structure of the apparatus in thin sections since only part of it is seen (the larger cells are 30μ , or even larger, in diameter) and in thick sections the superimposed portions cannot be seen and disentangled readily. Observations were made therefore on both thin serial sections and medium sections.

In the affected areas, the Golgi apparatus of even the smaller cells becomes considerably enlarged and occupies a large part of the cell protoplasm. As well as occupying the main portion of the cell as it does in the resting state, it extends into the protoplasmic processes. This results in gross irregularities of contour.

In some of the cells the Golgi apparatus increases in amount *pari passu* with the cellular enlargement, but in many, especially the largest cells, the amount of Golgi material appears to be disproportionately large. The principal portion of the material adopts a peripheral position, though processes may

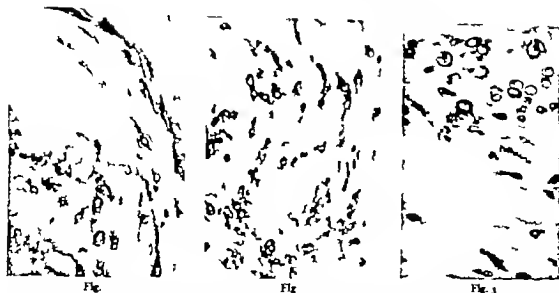


Fig. 2. Photomicrograph of portion of the all of cyst of the meniscus showing the greatly enlarged cells containing hypertrophied Golgi apparatus. The laterodular mucinous material is shown. The clear space is artefact. X264

Fig. 3. Photomicrograph of portion of the contents of

cyst of the meniscus showing large cells with hypertrophied Golgi apparatus. X264

Fig. 4. Photomicrograph similar to that shown in Figure 3, showing large cells. The peripherally distributed Golgi apparatus is shown cut in section. The nuclei are not apparent (See Fig.) X264

pass into the central area of the cell especially to and around vacuoles. In many cases this appearance which is very characteristic of some sections (Figs. 3, 9 and 10) seems to be due to shrinkage of the protoplasm toward the boundary of the cell and thus gives rise to eccentric condensation of the reticular material. In other cases however there is but little evidence of shrinkage and the peripheral position may be regarded as actual.

In a microscopic section, this structure is cut across so that it appears in more than one section. If the middle section is shown the Golgi apparatus appears as a ring which is, in places, more or less thickened (Figs. 3 and 10). If either the proximal or distal part is shown then the apparatus appears as a net work (Fig. 9).

At first sight these structures give the appearance of irregularly impregnated nuclei and in unstained sections were at first regarded as such. However when sections are stained (with alum-carmin, hematoxylin, etc.) the nucleus is readily recognizable lying within the cavity of the Golgi ring. Incidentally the photomicrographs illustrating

the morphology of the apparatus were made from sections lightly stained, so that the reticular material should not be overshadowed by other features. The nuclei therefore are not displayed clearly (Figs. 8 and 10). In stained sections also protoplasm can be discerned in the middle part of most cells, so that the explanation of an artefact nature of the ring appearance can only be partly true.

An appearance similar to this though less well developed is to be seen at times in cells of normal synovial membrane. At first I was content to regard it purely an artefact, but though it may be due partly to imperfect impregnation the observations made on cells in ganglia suggest that it is a type of structure which it is necessary to recognize.

The typical entire structure is a more or less complete basket which surrounds the nucleus and the vacuoles in the protoplasm. It is composed of an irregularly undulated sheet which in most cases, shows numerous fenestrations of varying shape and size. This gives a lattice work appearance which may be irregular but at times is remarkably regular in structure.



Fig 4



Fig 5



Fig 6

Fig 4 Photomicrograph of portion of wall of ganglion showing typical "synovial" lining. The deeply stained Golgi apparatus and the lighter nuclei may be seen in some cells $\times 350$

Fig 5 Photomicrograph of the wall of a cyst of the meniscus showing the Golgi apparatus of the cells. The

nuclei are recognizable as more lightly stained structures $\times 396$

Fig 6 Photomicrograph of portion of a cyst of the meniscus. The synovial lining is one cell thick and resembles endothelium $\times 264$

Although in many cells the basket is complete and in others incompleteness seems to be due to mechanical removal of portion of the structure during the preparation of the section, in other examples the basket seems to be genuinely incomplete or only partially developed. Whether the hiatus be regarded as a large fenestration or as imperfect development of the reticular material is probably immaterial in the present state of knowledge.

Between the typical cells and lying in the mucoid material there are small anuclear pieces of protoplasm which contain a certain amount of Golgi material. This is still well impregnated with silver and seems to be comparable with material observed in desquamated cells in actively secreting states elsewhere. In some of these the Golgi material is reduced to a number of granules instead of the usual network. This is the exception rather than the rule, however, usually as the protoplasm disintegrates the Golgi material disappears.

In the later stages, when the active process has subsided, the tissue lining the cyst shows cells, whose Golgi apparatus is closely similar

to ordinary synovial cells, i.e., it is a reticular mass about the size of the nucleus and occupying the main area of the protoplasm (Figs 4 to 6).

ANALYSIS OF STUDY

The study of tissues by any new—or previously unused—method of examination opens up avenues of approach to various problems, but at the same time results obtained by such methods require careful interpretation and may, in themselves, add further complications.

The material described here may be considered therefore from two points of view (a) in so far as it gives further information concerning the characteristics of the Golgi apparatus of cells in general and (b) as it helps to elucidate the questions of pathology.

a, The Golgi apparatus is a special part of the protoplasm of tissue cells, both animal and plant, which is demonstrated by staining by osmic acid or impregnation with silver. It appears to be fluid and lipoidal in nature. Not only has it been demonstrated in almost all cells but has been observed in unstained cells, so that there seems little doubt as to its actual

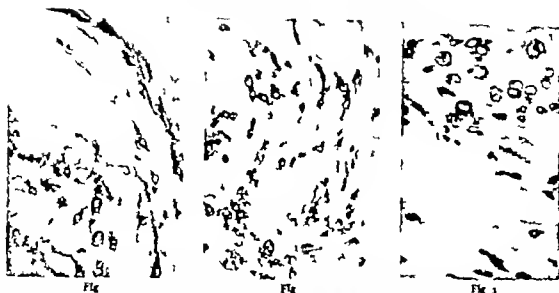


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Fig. 7



Fig. 8



Fig. 9

Fig. 7. Photomicrograph of the walls of adjacent cysts of the meniscus. $\times 300$

Fig. 8. Photomicrograph very similar to that shown in Figure 7. The highly stained border and the deeply

impregnated Golgi apparatus are clearly demonstrated. $\times 300$

Fig. 9. Photomicrograph of a group of cells showing the basket character of the Golgi apparatus in enlarged cytoplasmic cells. $\times 305$

existence i.e. it is not an artefact. It has been shown to be associated closely with the production of secretion products by so many observers that a relationship between it and the formation of secretion is now definite. The way in which it forms or modifies secretion granules is still uncertain but it is not necessary to discuss such details here.

When a cell becomes active and secretion occurs, the Golgi apparatus becomes hypertrophied sometimes greatly so and with

cessation of secretion it again becomes smaller. Different kinds of change have been observed in different cells, in these circumstances, but increase in the amount of the Golgi material is invariable. Sometimes there is dissemination to and occupation of all parts of the protoplasm.

In the examples described here there is an extraordinary hypertrophy of the Golgi material. In thick sections the basket character of the material is very readily seen. Such forms have been described in other cells (3) but I have not observed any cells or seen illustrations which show this feature so well as do the large cells in the walls of developing ganglia.

Another morphological feature of the apparatus described by Hirschler and Bowen is its essentially lamellar structure. Bowen considered that the characteristic reticular appearance is what would be seen on optical section of curved plates. I have been unable to satisfy myself that this is so for some cells, but in others there is no doubt of the lamellar architecture. This is well shown in some of the large cells in developing cysts of the meniscus and ganglia. In some cases the lamellae are unbroken but usually there are openings of

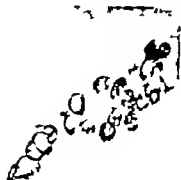


Fig. 10. Photomicrograph similar to that shown in Fig. 9, some of the cells are shown only in middle zone. $\times 305$

varying size and shape in the plates giving an irregular lattice-work appearance

Secretory granules were not demonstrated but the vacuoles were closely associated with portions of the Golgi apparatus, usually surrounded completely or in part by the impregnated material

In these conditions therefore, when the Golgi apparatus is an extremely well developed and robust body, it is easy to determine the general features of its structure

b, Relatively few observations have been made on the changes occurring in the Golgi material in pathological conditions. Disintegration of the apparatus has been shown to occur when cells undergo degeneration and autolysis. This is well shown in degenerative areas in tumors and is reflected in the necessity for early fixation of tissue for the demonstration of the structure. It was sensitiveness of the Golgi material to adverse influences that suggested that the condition of it in ganglia might throw some light on the nature of the processes occurring

Various hypotheses have been put forward to account for the development of these cysts. In previous papers the writer has shown that the cysts both in ganglia (8) and in the menisci (7) come to be lined by a connective tissue which is like synovial membrane. Others have confirmed this, hence the hypotheses depending on the supposition that they are lined with endothelium need not be considered

Several writers however refer to the development of cysts as being due to mucoid degeneration (1, 2, 5). In the papers mentioned (7, 8) the writer submitted the opinion that the process was not degenerative because, in the mucoid areas, the cells were well developed, the nuclei did not indicate any degenerative change, and in the protoplasm of the cells there were secretion droplets

In so far that in the fully developed condition there are no apparent cells in the cyst fluid, the cells originally occupying this area must have died. To this extent a "degeneration" has occurred. However the problem is whether this degeneration is primary or merely incidental to the particular form of cellular activity and also probably to the segregation of the cells from their blood

supply by the very mass of mucoid material formed and therefore secondary to such activity. It would seem reasonable not to employ the term "degeneration," which has come to be used loosely for conditions which are normal and physiological. It is not employed in describing secretion e.g., in the epithelium of the alimentary canal, where some cells are cast off during secretory activity. *A priori*, since degeneration means a breaking down it seems unlikely that such a process could result in the formation of a very complex protein—i form of muen

In the material presented here there is another item of evidence. In the areas of mucoid change there are, in the enlarged cells, extraordinarily well formed, indeed complicated, Golgi bodies. Many of these present a complex and intricate structure. Their complexity apparently is due in large part to the accommodation in a relatively small space of a greatly hypertrophied structure. Surface irregularities are to be correlated with irregularities in the shape of cells. Spherical or ovoid cells contain rounded or ovoid bodies. In some of the smaller, i.e., those which are disintegrating—as do cells in active secretion elsewhere, e.g., mucous cells—the Golgi material is still well formed and is just as deeply staining as is the material in the larger cells or the normal cells in the same section but at a distance from the affected area. Indeed, all the Golgi material in the "degenerative" regions is much more obvious than is that in the normal zones. Several of the observations which I have made on synovial membrane were first carried out in this tissue, the significance of minor variations of structure, etc., only becoming apparent in these robust and easily observed bodies

From the point of view of the Golgi apparatus therefore there is no evidence of "degeneration" in the areas of mucoid accumulation until a very late stage. The affected cells show, for a considerable time, a normal or active nucleus and normal though more voluminous protoplasm containing well developed organelles

SUMMARY

The tissue cells of ganglia and cysts of the menisci contain droplets of mucinoid mate-

rial etc. which resemble the results of cellular activity more closely than those of protoplasmic disintegration.

The Golgi apparatus of these cells is hypertrophied and extremely complex in structure and this strongly supports the view that cytological changes are due to cellular activity rather than retrogression.

Since some forms of physiological secretory activity result ultimately in disappearance of cells, this might be regarded as a degeneration but in such cases this is a normal process and thus is different in degree as well as in kind from other true (or primary) degenerative conditions. The formation of normal joint fluid is such a process, and the changes in ganglia, etc. are of the same kind.

The areas of intercellular mucinoid degeneration," which are the early stage of development of cells, are thus the result of secretion.

Ganglia and cysts of the menisci therefore may be regarded as abnormal new joint

spaces and are not fundamentally degenerative.

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IRRITATION OF THE RESPIRATORY TRACT AND ITS REFLEX EFFECT UPON THE HEART

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IT has been recognized for some time that during anesthesia with intratracheal technique, particularly in the lighter planes, there may arise abruptly, dramatically marked respiratory difficulty and very obvious circulatory derangement. Probably, this happens most frequently with cyclopropane. These disturbances, however, after a variable period of time suddenly vanish leaving no clue as to their causal genesis or of the mechanism of their disappearance.

These phenomena seemed worthy of investigation by means of the electrocardiograph especially in regard to the part played by the heart in these circulatory derangements. It was felt that various mechanical appliances regularly employed in the closed types of anesthesia might play a provocative rôle in these most undesirable reactions. Accordingly, a series of patients who received uniform pre-operative preparation but different anesthetic agents were studied by the electrocardiograph, during the actual insertion of the tube, inflation of the cuff, spraying of the throat, or the introduction of the bronchoscope. Many records were made both before and immediately after instituting these different forms of irritation in the respiratory tract.

The present study embraces 35 patients. While electrocardiographic changes appeared in a fairly high percentage, in 10 there seemed to be indisputable reflex effects upon the heart as a result of the irritation of the mechanical agents used in the respiratory tract. Seven of these cases are presented as illustrating the wide variety of cardiac reactions encountered.

PRESENTATION OF CASES

CASE 1 No 3368 Lead 2 in Figure 1 Cyclopropane anesthesia was used. The left part of the upper

From the New York Medical College and Flower Fifth Avenue Hospital

tracing shows a regular sinus rhythm, the insertion of the tube coincides with the beginning of the tracing, there appears suddenly marked vagal inhibition with escape of deeper auricular centers and also escape of one ventricular center, then a group of three auricular extrasystoles appears, followed by single extrasystoles. In the lower tracing one sees a similar arrhythmia with bradycardia and auricular extrasystoles during removal of the tube (at beginning of tracing) following which there is a rather rapid return to a normal sinus rhythm. In this part of the tracing there is some deformation of the tracing caused by movement of the patient.

CASE 2 No 3558 Lead 2 in Figure 2 Cyclopropane anesthesia was used. In this case the tube was introduced and allowed to remain in position for a time. The white perpendicular line on the left side of the tracing is a signal marking the beginning of the inflation of the Water's cuff, one sees immediately, thereafter, prolongation of the P-R interval in some beats, marked prolongation of conduction time of a few auricular extrasystoles and later vagal inhibition with one escape beat, then a return to normal sinus rhythm.

CASE 3 No 3286 Lead 2 in Figure 3 Cyclopropane, nitrous oxide, oxygen and ether anesthesia was used. In this case a regular sinus rhythm is present until insertion of the tube when immediately ventricular extrasystoles appear with an escape beat after the first extrasystole.

CASE 4 No 3264 Lead 2 in Figure 4 Cyclopropane, nitrous oxide, oxygen, and ether anesthesia was used. The tracing at the left, before tube insertion, and the one at the right, after tube insertion, show regular sinus rhythm. In the middle portion of the tracing only, during insertion of the tube, one sees variable ventricular extrasystoles.

CASE 5 No 3362 Lead 2 in Figure 5 Nitrous oxide, oxygen, and ether anesthesia was used. Upper tracing shows a regular sinus rhythm with low T-waves. During insertion of tube, lower tracing, the sinus rhythm disappears and a regular auriculo-ventricular rhythm appears without P-waves, near the end of the tracing sinus rhythm reappears.

CASE 6 No 3425 Lead 2 in Figure 6 Nitrous oxide and oxygen anesthesia was used. Upper tracing represents a control with regular sinus rhythm. During insertion of the tube, left lower tracing a marked bradycardia appears with blocked auricular extrasystoles. Then the registration had to be stopped because of patient moving, following which in the right lower tracing is seen a gradual disappearance of bradycardia with return of normal sinus rhythm.



Fig. 1953 Vagus inhibition with escape of deeper centers and auricular extrasystoles during insertion of tube

and reappearance of normal rhythm immediately after tube removal (cyclopropane)

CASE 7. Lead 3 in Figure 7. Nitrous oxide and oxygen anesthesia was used. The upper tracing shows regular sinus tachycardia with T waves. During insertion of the tube lower tracing many aricular extrasystoles appear and the heart rate increases.

These tracings show such alterations as extrasystoles, both auricular and ventricular delayed conduction time slowing of the heart with escape of deeper centers, etc. It is well known that arrhythmias during anesthesia, particularly with cyclopropane, are very common. However in our experiments it was very striking that these changes in the electrocardiogram occurred only during the mechanical irritation caused by insertion of the tube or inflation of the cuff etc. and disappeared when the irritation had ceased. Moreover according to Robbins and Baxter prolongation of the P-R interval and the severer types of auriculoventricular block cannot be assumed to be an effect of cyclopropane.

The explanation of these effects on the heart coming on immediately after insertion of the tube or inflation of cuff, etc. and occurring at no other time can be explained adequately only by assuming a sudden increase in vagal tone. This is intelligible only in terms of a reflex in these instances from the upper respiratory tract to the heart.

The evidence that such cardiac reflexes are of a vagovagal type whether originating in

the trachea, larynx, bronchi, or lung is substantiated in a way by the fact that all these effects can be duplicated by carotid sinus reflexes (6, 11) moreover the injection of acetylcholine has given very similar electrocardiographic findings, Scherf (20) and Barnes (16).

HISTORY

The older literature contains many references to pulmocardiac reflexes (4, 9, 19) and these have been further extended by many recent contributions (12-25) all of which have been well summarized by Schweitzer. There are two obvious ways of explaining these effects:

1. Reflex effects upon the heart centers, such as sinus node, auricular ventricular node etc. The inhibition of the heart such as bradycardia and auriculoventricular block as well as auricular and ventricular extrasystoles may very well follow as is well known, from vagal effects being transferred to the specific tissue or to the myocardium itself.

2. Reflex effects on the coronary artery with alteration in blood flow volume and rate, etc. The extrasystoles might also be explained upon the basis of a pulmocoronary reflex. This pulmocoronary reflex was first suggested by Scherf and it is well known that the electrocardiogram in pulmonary embolism may be similar and frequently is indistinguishable from that found in coronary



Fig. 1955 Prolonged conduction time, sinus inhibition and escape beat during cuff inflation (cyclopropane).

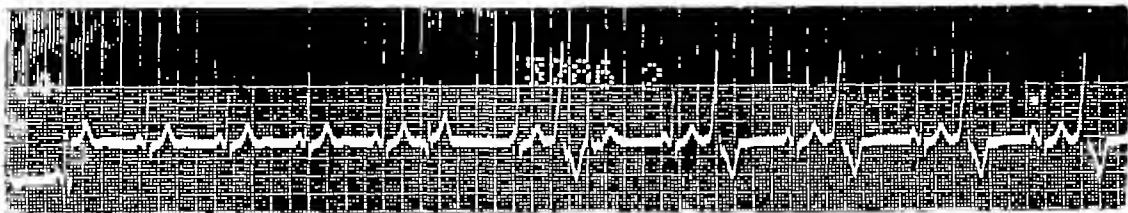


Fig 3 3286 Ventricular extrasystoles immediately after insertion of tube (cyclopropane, N_2O , O_2 , ether)

thrombosis. Decreased coronary blood flow may very well initiate extrasystoles, but due to the type of *T*-wave found in the electrocardiograms of the present study it is not probable that there was a particularly marked decrease in the blood flow in any very large or extensive areas of the myocardium.

The experimental contributions in the literature which would substantiate this reflex conception are many, and a few may be mentioned at this time. One of the best known is the so called Kratschmer reflex in which irritation of the nasal mucosa by gases, faradic currents etc, gives rise to cardiac inhibition and respiratory disturbances. Churchill and Cope have shown that the slowing of the heart and the rapid shallow breathing in congestion and edema of the lungs are dependent upon a nervous mechanism, and this is probably a vagovagal reflex from the lungs to the respiratory center and heart. Harrison et al (7, 8) have shown that increased pulmonary blood pressure either arterial, capillary, or venous, reflexly stimulated respiration but no effect took place if the vagi were cut. H E Hering (10) in 1920, showed pressure on larynx of the rabbit produced bradycardia, others have found the same effect in anesthetized dogs, also that it disappeared after atropinization. Sauerbruch (18), in 1932, described cardiac inhibition of such severity as occasionally to lead to death at the very instant the bronchus was constricted. Felix has made similar, even more

suggestive, observations, in that repeated trauma to the bronchial mucous membrane led to cardiac arrest, and what is particularly important this occurred only during the bronchial irritation.

R Nissen reported that on constricting a bronchus during a lobectomy in a girl of 12 years, there arose a temporary cardiac arrest, and subsequent touching of the bronchus gave a similar result. Adrian has shown that pulling up on the trachea increases the number of afferent vagal impulses, while pulling down decreased them.

The anatomical basis of the foci for the origination of these reflexes has recently been described by several workers. According to O Larsell there are three groups of nerve plexuses in the lung (1) bronchial group, (2) vascular group, and (3) pleural group. More recently, Sunder-Plassmann has brought excellent anatomical evidence to support this conception, and has added details of the nerve distribution in the intrapulmonary bronchi. Sunder-Plassmann states that the nerve supply to the bronchi is not unlike that of the gut, and he has demonstrated the existence of large numbers of nerve elements in the heavy connective tissue arranged in bundles around the bronchi. He also described other forms of nerve receptor elements in the epithelium of the intrapulmonary bronchi.

The course taken by the impulses originating in the respiratory passages apparently may take one of three different paths and



Fig 4 3284 Variable forms of ventricular extrasystoles during insertion of tube (cyclopropane, N_2O , O_2 , ether)

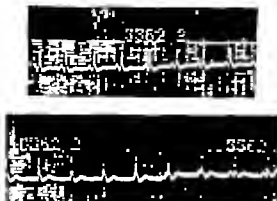


Fig. 5 3362. Atrial-ventricular rhythm during insertion of tube (N_2O O_2 ether)

possibly, under certain conditions, may travel over all. These are (1) impulses originating in respiratory passages may go by afferent vagal fibers to the vagal center and then by efferent fibers to the heart (2) axon reflexes within the vagal network and hence pass from lung to heart without going through the centers (3) spread or irradiation of vagal impulses through various ganglia to the sympathetic nerves and hence to the heart.

The first would seem to be the most frequent occurrence and undoubtedly impulses arriving at the vagal center over the afferent nerve would spread to involve the respiratory center as well as efferently to heart. In addition there are direct afferent vagal fibers to the respiratory center. The second probably occurs although the experimental evidence for it is not complete. It was found by Carlson and Luckhardt that electrical stimulation of a

lung in decerebrate frogs and turtles produced reactions on the heart and blood pressure. Others have reported similar findings. This represents some form of axon reflex within the autonomic nervous system. Also in this connection it should be mentioned that Soma Weiss has produced similar electrocardiographic tracings by inflating a balloon in an esophageal diverticulum. The electrocardiographic alterations were prevented by atropine. This leads one to suggest that the respiratory passages are potential loci for the origin of vagovagal reflexes which may be initiated by mechanical irritation from various agents, such as catheters, McGill tubes, cuff inflations, bronchoscopes, spraying of the throat etc. These reflexes may then produce either a narrowing of the coronaries with resulting decrease in myocardial blood flow or induce profound alterations in the reaction of the specific tissue of the heart. The net result of this is usually a marked derangement of cardiac activity.

Regarding the respiratory disturbance it may be said that this is also assumed to be of reflex origin the reflexes having the same source and initiating cause. The evidence for this respiratory reflex is not so complete as that for the heart however when one considers the abruptness of onset, the intimate association with obvious mechanical irritation, and the rapidity of its disappearance the assumption of a reflex mechanism seems to have considerable basis. For example it is well known that deep inspiration and expiration combined with coughing and closing of the glottis can produce extrasystoles, or if present



Fig. 6 3435. Atrial-ventricular block and marked bradycardia with escape beats during insertion of tube (N_2O and O_2)

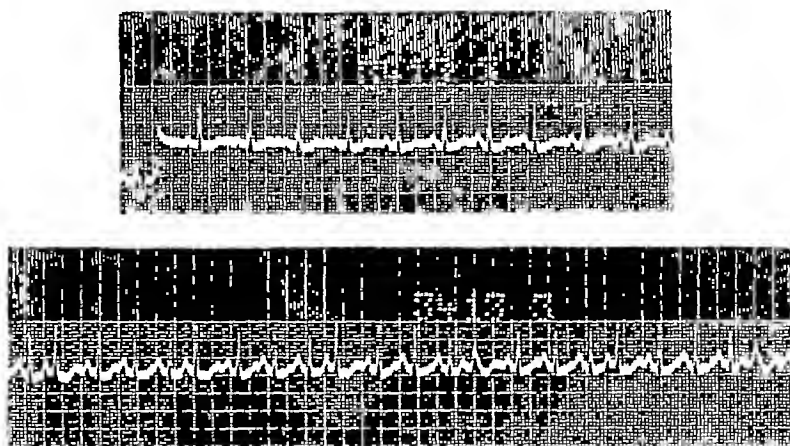


Fig 7 3413 Tachycardia and auricular extrasystoles during insertion of tube
(N₂O, O₂) LD 3

even cause them to vanish. This fact finds therapeutic application by some patients with paroxysmal tachycardia, sometimes with quite spectacularly beneficial results. Of course, it is self evident that the percentage of occurrences depends on several conditions among which may be mentioned state of receptors in trachea, bronchi, etc., the status of the autonomic nervous system, and the state of the effectors in heart, vagal center, and respiratory center.

The occurrence of such a high percentage of alterations in the electrocardiograms in this investigation may very well be explained on the changes in the cardiac effectors because of the action of an anesthetic agent. Accordingly, there is clinical and experimental evidence which indicates that reflexes originating in the respiratory tract and passing to the heart, vagovagal in type, can be initiated rather frequently on the introduction of mechanical agents of various kinds into the respiratory passages. This mechanism may serve to explain many sudden deaths such as occur on water emersion when no water is present in the lungs and resuscitation fails (Scherf and Boyd, 21).

It might be recalled here that morphine increases vagal tone and therefore has a tendency to enhance or potentiate the action of vagal reflexes. This is important in view of its widespread use as a pre-operative medication. On the other hand, atropine has a highly

specific effect in abolishing or minimizing vagal effects, and therefore would seem to possess the great advantage of decreasing if not actually preventing many of the undesirable features potentially present in vagovagal reflexes. This would seem to constitute excellent evidence as to its high value in pre-operative preparation and gives further justification for its almost universal use combined with morphine under these circumstances.

SUMMARY

- 1 Irritation of any kind, particularly that of mechanical agents in the respiratory tract may initiate reflexes within the autonomic nervous system having as its result, cardiac inhibition with altered function of the specific tissue, and resulting in a marked circulatory derangement.

- 2 These same irritations may set up reflexes leading to marked effect on respiratory center with profound alteration in respiratory activity.

- 3 These reflexes are very important at any time, but particularly so in light anesthesia or in structurally altered hearts, for all hearts under anesthesia are functionally deranged. In other words, a normal heart under anesthesia is vulnerable to derangement from vagal stimulation or vagovagal reflexes as is a structurally altered heart without anesthesia.

- 4 The conclusion seems warranted that the introduction of mechanical devices into

the respiratory tract especially in light anesthesia, is not without danger and all such contemplated procedures should have adequate pre-operative therapy the object of which should be the minimization or prevention of the undesirable reactions potentially present in autonomic reflexes.

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Fig. 1. Melano-epithelioma of the cheek, with metastatic involvement of the upper cervical lymph nodes of a man, 58 years of age. Patient is alive and well 10 years after removal of the tumor and dissection of the neck.



Fig. 2. Boy, 3 years of age, with squamous cell epithelioma, grade 3 of the lower lip.

old boy who had metastasis to the sub-mandibular lymph nodes is the youngest patient known to have had an epithelioma of the lower lip. This case has been reported by Kondratenko.

The youngest patient in our series was a boy of 13 years (Fig. 2) who had a grade 3 squamous cell epithelioma of the lower lip. When last heard from he was alive and well 6 years after operation.

Forty-three of our 233 patients (18.5 per cent) had squamous cell epithelioma of the lower lip. One additional patient had a basal cell epithelioma of the upper lip. Of this group of 43 patients, 20 gave a history of a preceding lesion such as a crack, fissure or scaling area. Thirty-nine of these patients were males and 4 were females. The average duration of signs or symptoms before these patients came to the clinic was 1.8 years.

Eighteen of these patients had lesions of grade 1 malignancy, 18 of grade 2, 3 of grade 3 and 2 of grade 4. In other words, 36 (84 per cent) of these squamous cell epitheliomas of the lower lip were of the two lower grades of malignancy. In a much larger series of cases of similar lesions in patients of all ages, Broders found that 78 per cent were of the two lower grades of malignancy. The method of treatment used for cancer of the lip has been given before by one of us (New 5).

Of the total of 44 cases of epithelioma of the lip, 5 showed involvement of the cervical lymph nodes as proved by microscopic examination. Four of these 5 patients died.

TABLE 1—FIVE YEAR SURVIVALS ACCORDING TO TYPE OF LESION

Lesion	Patients treated	Patients traced	Lived, years or more, but diseased	
			Number	Per cent of those traced
Squamous cell epithelioma, grade 1	12	10	13	90
Squamous cell epithelioma, grade 2	17	14	17	100
Squamous cell epithelioma, grade 3				51
Squamous cell epithelioma, grade 4	10	10		
Basal cell, oral basal and squamous cell, epithelioma, grade 3	17			100
Melanocarcinoma (oral cancer)	12	10	11	88
Fibrosarcoma	17			11.5
Lymphosarcoma				
Melanocarcinoma				—
Lymphoma and hemangio-endothelioma				—
Melanocarcinoma				—
Total	129	118	215	181

within 2 2 years, the remaining patient was living and well 11 years after surgical treatment. This emphasizes the fact that metastasis to the lymph nodes renders the prognosis much more grave, although the fact that 1 patient who had a squamous cell epithelioma of grade 3 was living and well 11 years later shows that the prognosis is not hopeless. In this latter case the lip lesion was excised, with bilateral dissection of the lymph nodes of the neck. Twenty-seven other patients in this group underwent bilateral dissection of the cervical lymph nodes but none of the nodes showed any evidence of metastasis. Twenty-two of these patients were traced 2 died within 2½ years, whereas the 20 remaining lived 5 years or more. Tables II and III reveal further that approximately 84 per cent of the patients who were traced were living 5 years or more, and 78 per cent were living 10 years or more after treatment. These figures compare favorably with those reported previously. In a much larger series of cases of epithelioma of the lower lip, irrespective of age, it was found that 75 per cent of the patients lived 5 years or more (5).

While the number of patients in this group is small, it seems reasonable to conclude from these data that the prognosis for epithelioma of the lower lip in persons less than 30 years of age is apparently just about as good as that in older persons, probably owing to the large percentage of growths of low grade malignancy.

TABLE II — FIVE YEAR SURVIVALS ACCORDING TO LOCATION

Location	Patients treated	Patients traced	Lived 5 years or more after treatment	
			Number	Per cent of traced patients
Face	44	30	23	76.7
Parotid and submaxillary region	51	41	37	90.2
Lips	43	38	32	84.2
Tongue palate tonsil pharynx	47	41	12	29.3
Upper jaw and antrum	20	19	7	—
Lower jaw	8	7	3	—
Larynx	6	6	2	—
Total	210	182	116	63.7

83 per cent traced 5 years or more

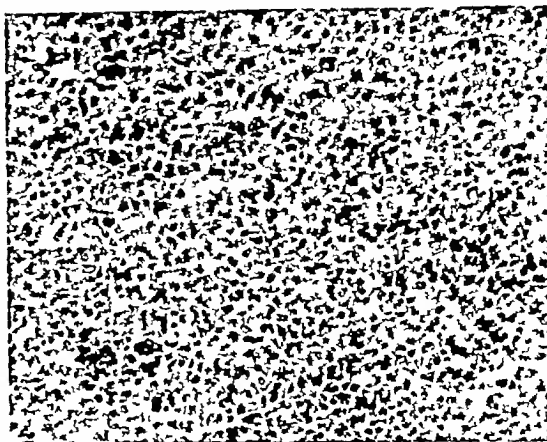


Fig. 3 Lymphosarcoma of the antrum of a woman, 26 years of age, treated with radium and roentgen rays. Patient was alive and well 9 years later.

ANTRUM AND UPPER AND LOWER JAWS

The antrum of Highmore may be the seat of a large variety of tumors, both benign and malignant. Both carcinoma and sarcoma may occur. One of us (New, 5) in a large series of cases found that squamous cell carcinoma is the predominant tumor involving the upper jaw and antrum.

There were 31 cases of malignant neoplasms of the antrum and of the upper and lower jaws in this series. Of the 16 tumors primarily involving the antrum, 8 were squamous cell carcinomas, 3 lymphosarcomas (Fig. 3), 2 fibrosarcomas, and 1 each of the following: hemangio-endothelioma, adenocarcinoma, and adenocarcinoma of the mixed tumor type. Of the 6 tumors of the upper jaw, 2 were squamous cell carcinomas, 2 fibrosarcomas, and 2 adenocarcinomas, 1 being of the mixed tumor type. There were therefore 22 tumors of the upper jaw and antrum (almost 10 per cent of the entire series), and, of these, 10 were squamous cell carcinomas. Nine of these 10 were grade 3 or 4 malignancy.

The youngest patients in this group were a 2 year old boy who had a fibrosarcoma of the lower jaw, and a 4 year old girl, who had a fibrosarcoma, apparently primary in the upper jaw.

The average duration of symptoms for tumors of the antrum before the patient came to the clinic was 7 months, 1 3 years for lesions

TABLE III.—TEN YEAR SURVIVALS ACCORDING TO LOCATION

Location	Patients treated	Patients traced	Lived ten years or more after treatment	
			Num. Surv.	Per cent of traced patients
Face	34			
Perioral and submaxillary regions	26	26		
Lips	53	27		51%
Tongue, palate, hard, pharynx		23		18
Upper jaw and antrum		17		—
Lower jaw				—
Larynx				—
Total	26	267	64	29

No per cent traced so far as more

of the upper jaw and 23 years for lesions of the lower jaw

The method of treating malignant tumors of the jaws and antrum has been described previously (5)

In view of the fact that the number of patients in this group is so small we have not given any percentage figures in the survival tables (Tables II and III). Cabot and one of us (New) reported for all age groups the following 5 year survival figures for malignant growths of the upper jaw and antrum 54 per cent for malignant growths of the lower jaw 60 per cent.

BUCCAL CAVITY AND PHARYNX

Malignant neoplasms of the tongue are usually squamous cell carcinomas. A few rare cases of sarcoma have been reported. Carcinoma of the tongue despite the fact that it is readily recognizable in its early stages, is nevertheless one of the most fatal of malignant diseases.

Malignant neoplasms of the palate are usually adenocarcinomas of the mixed tumor type or squamous cell epitheliomas. Sarcomas may also be found in this region but they are less common than the other types.

Malignant tumors of the tonsil are usually squamous cell carcinomas, one of us (New) and Childrey having found such lesions to be almost five times as common as all other types of malignancy of the tonsil combined.

There were 6 cases of malignancy of the tongue in our series, all squamous cell epitheliomas and 5 of the 6 tumors were of the higher grades of malignancy. There was only 1 tumor of the tonsil a lymphosarcoma. Of the 7 tumors of the palate 5 were adenocarcinomas of the mixed tumor type the 2 remaining being respectively a fibromyxosarcoma and a hemangio-endothelioma. The largest number of neoplasms in this group were in the pharynx. Of these 37 growths, 21 were squamous cell epitheliomas, 6 were lymphosarcomas 5 were adenocarcinomas of the mixed tumor type 3 were fibrosarcomas, 1 was a hemangio-endothelioma, and 1 was an adenocarcinoma. The pharyngeal epitheliomas were all of grades 3 and 4.

The youngest patient with cancer of the tongue was a woman (Fig. 4) 22 years old who had a grade 4 squamous cell epithelioma involving the tip of the tongue. This is a very unusual case because following radium and roentgen therapy this patient was still living and well 5½ years after treatment. (During the past year a 13 year old boy (Fig. 5) who had a grade 4 squamous cell epithelioma on the left margin and base of the tongue was seen at the clinic.) A 7 year old girl was the youngest patient with a malignant lesion of the palate. She had a fibromyxosarcoma and died 3 months after treatment. The 1 patient with lymphosarcoma of the tonsil was a man 29 years old. He died 8 months after the onset of symptoms. The youngest patient with a pharyngeal lesion was a boy 3 years old with grade 4 squamous cell epithelioma. He died within 2 months of the onset of symptoms.

The method of treatment of malignant disease of the tongue, tonsil, pharynx, and palate has been described previously.

Tables II and III reveal the high mortality for this group of lesions. After 5 years, only 29 per cent of the 41 patients who were traced were alive and 10 years after treatment only 18 per cent of the 22 patients who were traced were alive. This is undoubtedly partly due to the fact that the lesions were of such a high grade of malignancy. Twenty-six of the 27 squamous cell epitheliomas were of either grade 3 or 4, which again gives much support to Broders' thesis that the most important

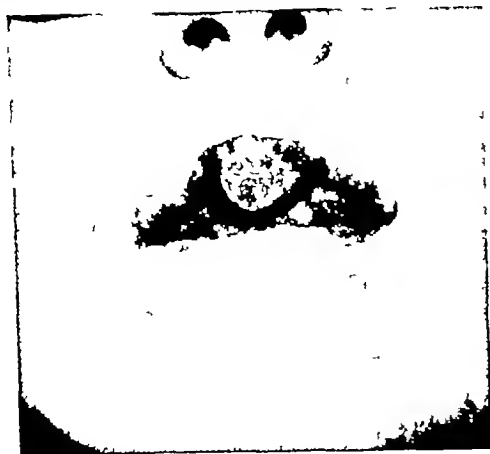


Fig 4 Woman, 22 years of age, with squamous cell epithelioma, grade 4, of the tip of the tongue. The growth had not recurred 8 years following its removal and treatment with radium

factor in prognosis is the grade of malignancy. The high mortality for this group of patients with lesions of the tongue, palate, tonsil, and pharynx corresponds in a general way to the statistics for all age groups. One of us (New, 5) in a series of 156 traced patients who had epithelioma of the tongue, reported that 37 per cent were living 5 years or more after treatment. Figs 1 and one of us (New) reported 26 per cent of patients with epitheliomas of the pharynx and tonsil living 5 years, and 54 per cent with lymphosarcomas in the same region living 5 years after treatment.

LARYNX

Malignant tumors of the larynx are infrequent in persons less than 30 years of age, although they do occur. Recognition of this fact is of great value from the standpoint of diagnosis and treatment.

Of the malignant growths in this region the majority are of epithelial origin. Sarcoma is infrequent. The typical neoplasm is the squamous cell epithelioma.

Carcinoma of the larynx is most common in adults beyond middle age, and it is much more common in men than in women. In a group of more than 380 cases Figs 1 and one of us (New, 3) found that 84 per cent of the patients were between 40 and 70 years of age, only 5 per cent were less than 40.



Fig 5 Boy, 13 years of age, with squamous cell epithelioma, grade 4, of the left margin and base of the tongue

In our series there are 6 malignant neoplasms of the larynx. These were all squamous cell epitheliomas, 2 each of grades 2 and 3 (Fig 6), and 1 each of grades 1 and 4. These 6 cases were divided equally with respect to sex. Four of the 6 patients were between 20 and 30 years of age. The youngest patient in this group was 2 years of age. She was first seen in 1929 and had had symptoms for a year. Microscopic examination revealed a papillary squamous cell epithelioma of grade 1. The patient was treated over a period of 3 years with roentgen rays, radium, and diathermy for recurrences, but she died eventually in 1934. The method of treating carcinoma of the larynx has been described previously (6).

The prognosis for carcinoma of the larynx in young persons is poor (Tables II and III). Of the 6 patients, 2 were alive and well 5 and 6 years, respectively, after surgical intervention. The 4 remaining died within 4 years.

In a group of 107 patients of all ages with carcinoma of the larynx Figs 1 and one of us (New, 9) reported 65 per cent living 5 years or



Fig. 6. Squamous cell epithelioma, grade 3, of the larynx of boy 5 years of age. There is no evidence of recurrence 5 years after operation.

more after operation. None of the patients who had a grade 4 carcinoma lived 5 years.

PAROTID AND SUBMAXILLARY REGIONS

Most of the neoplasms in this group are of the parotid region. We have considered in this group all tumors in and about the parotid and submaxillary salivary glands. In this series there were 52 cases of malignancy involving the parotid and submaxillary region. Forty-eight of the lesions were adenocarcinomas (mixed tumor type) 2 were squamous cell epitheliomas, 1 was a melano-epithelioma, and 1 a hemangio-endothelioma. Of the 52 patients 31 were females, 21 males. The youngest patient in the group was a 7 year old boy. Sections through the tumor in this case showed typical adenocarcinoma plus a squamous cell epithelioma of grade 2. This boy was living 10 years after excision of the tumor and subsequent roentgen treatment.

The average duration of symptoms prior to the time this group of patients came to the clinic was 3.75 years. The usual low grade of malignancy of these tumors makes the prognosis much better than for other lesions in this study. Of the 41 patients who were traced 37 or 90 per cent were alive 5 years later (Table II). Of 19 traced and hence eligible for 10 year survey, 14, or 74 per cent, were alive.

Although the prognosis for these patients is good, one must always bear in mind that the

tumors frequently recur if they are not completely removed at the primary operation. One of our patients first came to the clinic in 1918 at the age of 24 years with a recurrence after a former operation. He then returned several times later because of recurrences, and 20 years after his first visit he returned with an extensive recurrence.

SUMMARY AND COMMENT

This study was limited to patients in the first three decades of life. As was to be expected the number of cases of malignant disease increased with each succeeding decade. It was interesting to note that the distribution by sex during the first and second decades was almost equal 33 males to 30 females. It was in the third decade that the predominance of males occurred. In this decade there were 107 males as contrasted with 63 females.

It was of interest likewise to note the incidence of carcinoma and sarcoma. Twelve per cent of the lesions were sarcomas, 88 per cent carcinomas.

There were 100 cases of squamous cell epithelioma, and the 5 year survival figures (Table I) were similar to those of other observers. In other words there is real prognostic value in grading such malignancies, for one can offer the patients with grade 1 lesions a 90 per cent chance for recovery whereas the prognosis for those with grade 4 lesions is very poor. As was to be expected patients with basal cell and combined basal cell and squamous cell epithelioma of grade 1 showed 100 per cent 5 year survivals. Eighty-eight per cent of the patients with adenocarcinoma of the mixed tumor type were alive 5 years after treatment. Patients with sarcomas had a poorer prognosis. Fifty four per cent of the patients with fibrosarcoma were alive 5 years later. Only 22 per cent of those with lymphosarcoma lived 5 years.

Malignant disease of the tongue, palate, tonsil, pharynx, upper jaw and antrum, lower jaw and larynx in young persons is thought to carry a very poor prognosis. Table II however shows that of the 73 patients who were traced 24 (32.9 per cent) were living 5 years after treatment, and Table III shows that of the 36 patients who were traced 11 (30.6 per

cent) were living 10 years after treatment. If one includes cancers of the lip, of the 111 patients who were traced, 56 (54.4 per cent) were living 5 years after treatment, and of 63 traced for 10 years, 32 (50.7 per cent) were living after treatment. Considering the locations of these neoplasms and the age of the patients, these survival figures are surprisingly high.

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AN EXPERIMENTAL STUDY OF URETERO INTESTINAL IMPLANTATION

III The Significance of Ureterocolocal Reimplantation in the Chicken

HENRY M WEYRALCH J A.B. M.D. F.A.C.S., and FRANK HINMAN A.B. M.D. F.A.C.S.,
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IT IS logical to assume that if it were possible to reproduce exactly those conditions which exist in vertebrates whose ureters empty into a cloaca, the success of uretero-intestinal anastomosis would be assured. In these animal phyla the ureters open into a highly contaminated field without the occurrence of spontaneous infection of the urinary tract or other disastrous consequences. Smears and cultures of urine obtained from the ureters of 4 chickens failed to show the presence of any organisms. Nor was any evidence of renal infection observed upon the gross examination of 40 chickens and a microscopic examination of half this number. Identification by culture of the cloacal flora in 4 chickens demonstrated the pathogenicity of the natural content. *Bacillus welchii* was found in 2 instances, non-hemolytic *Escherichia coli* in 4, proteolytic flora in 3, *Bacillus paracoli* in 1 instance and *Staphylococcus albus* in 1.

In a previous communication we have demonstrated the fact that there was no anatomical barrier to ascending infection at the ureterocolocal entrance although certain peculiarities, i.e. an abundance of lymphoid tissue and a columnar type of ureteral epithelium were noted. The purpose of the present study is to determine whether these peculiarities of structure or some power of natural resistance provide an immunity to infection of the urinary tract.

The problem has been attacked by observing the effects of ureterocolocal reimplanta-

tion in the chicken. It was reasoned that, if these animals possess such a natural immunity, ureterocolocal reimplantation should be a benign procedure less hazardous than uretero-intestinal anastomosis in animals unaccustomed to a union of the urinary and intestinal tracts.

Because of the minute dimensions of the ureter and the feeble texture of the cloacal wall in the chicken, a submucosal or other elaborate type of ureterocolocal reimplantation was found impractical. For the present purpose therefore two simple operations were chosen: (1) a direct reimplantation following division of the ureter and (2) reimplantation of a rosette of cloacal wall bearing the intact ureteral orifice.

In both types of operation the exposure was identical, and the entire procedure was carried out extraperitoneally. The chicken was anesthetized with ether and a wide area surrounding the anus was denuded of feathers and prepared with iodine. By straddling the legs of the fowl over a small sandbag placed beneath the hindquarters it was found possible to elevate the anal region in such a manner as to present a readily accessible operative field.

A curved incision 4 centimeters in length which was made parallel and about 1 centimeter dorsal to the anus permitted entry to the retroperitoneal space. Because of a close attachment to the vertebral column careful dissection was found necessary to free the cloaca with the entering ureters. Identification of the ureters was facilitated by having an assistant insert an index finger into the cloaca in order to project the dorsal wall into the operative field. This procedure made readily possible the exposure of the ureters at their entrance into the cloaca (Fig. A)

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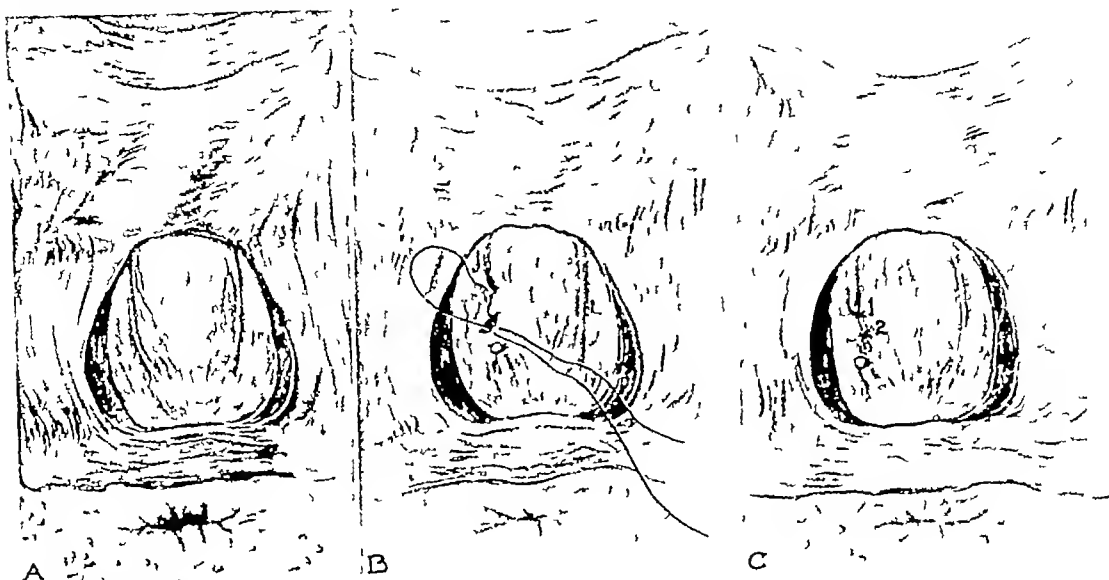


Fig 1 Ureterocloacal reimplantation in the chicken Direct method A, Retroperitoneal exposure of cloaca with entering ureters B, The left ureter has been divided, the distal stump ligated, and a transfixion suture placed through the proximal end The suture has been introduced

through an opening made into the lumen of the cloaca and is ready to be anchored in the wall of the cloaca a short distance beyond C, Anastomosis completed 1, Suture closing opening in cloaca 2, Suture anchoring end of ureter

In the direct method of reimplantation the ureter was dissected free and divided between clamps just proximal to its entrance into the cloaca. The distal stump was ligated with fine silk and the proximal end transfixied with a suture of No 0000 chromic catgut on an atraumatic needle. The transfixion suture entered the lumen of the ureter and emerged a few millimeters from the end through its dorsal wall. The ureter was reimplanted into the cloaca through a small transverse incision made a short distance proximal to the normal orifice, the two ends of the transfixion suture being passed into the lumen of the cloaca and out through all layers of the cloaca at a point distal to the incision (Fig 1, B). The end of the ureter was anchored by tying the transfixion suture, and the anastomosis was completed by closing the cloaca around the entrance of the ureter with one or more interrupted sutures of fine chromic catgut (Fig 1, C).

In utilizing the intact orifice, the lower part of the ureter was dissected free and the region surrounding the ureteral orifice tented up by traction on the ureter, thus permitting ex-

cision of a rosette of cloacal wall surrounding the orifice. A transfixion suture of No 0000 chromic catgut on an atraumatic needle was placed through the margin of the cuff, at a distance from the ureter, and anchored in a manner similar to the procedure in the previous operation (Fig 2, A). The ureter was reimplanted into the opening made by excision of the ureteral orifice, and the wound was closed around the entering ureter with interrupted sutures of fine chromic catgut (Fig 2, B).

Four one stage bilateral ureterocloacal reimplantations were performed, three by the direct method, one by the method of the intact orifice (Table I). All the chickens succumbed in from 2 to 5 days. In each instance the postoperative course was much the same. The chickens soon began to drink enormous quantities of water, they gradually became torpid, coma developed and death ensued. There was no means of estimating the urinary output. Although the excreta were noted to be more liquid than usual, this factor could be explained on the basis of the irregularities of the intestinal tract incident to the uremia.

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TABLE I—UNI STAGE BIATERAL URETERO-CLOACAL REIMPLANTATION IN THE CHICKEN

No. and sex	Operation	Result	Obstruction of urinary tract		Ascending infection		Remark
			Right	Left	Right	Left	
A. Direct reimplantation							
1 Hen	Bilateral direct reimplantation	Died 3 days	Hydronephrosis and hydro-ureter. Orifice occluded by caked material projecting into cloaca	Pyonephrosis and pyo-ureter. Orifice occluded by caked material projecting into cloaca	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	Infection of wound
2 Rooster	Bilateral direct reimplantation	Died 3 days	Hydronephrosis and hydro-ureter. Orifice not patent	Hydronephrosis and hydro-ureter. Orifice not patent	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	Peritonitis. Infection of wound
3 Hen	Bilateral direct reimplantation	Died 5 days	Hydronephrosis and hydro-ureter. Orifice not patent. Caked material adherent to projecting end of ureter	Hydronephrosis and hydro-ureter. Orifice not patent. Caked material adherent to projecting end of ureter	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	
B. Reimplantation of intact orifice							
4 Rooster	Bilateral reimplantation of intact orifice	Died 5 days	Hydronephrosis and hydro-ureter. Orifice not patent. Caked material adherent to projecting end of ureter	Slight dilatation of renal pelvis and ureter. Orifice not patent. Caked material adherent to projecting end of ureter	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	Peritonitis. Infection of wound

TABLE II—UNIATERAL DIRECT URETERO-CLOACAL REIMPLANTATION IN THE CHICKEN

No. and sex	Operation	Result	Necropsy		
			Obstruction of urinary tract	Ascending infection	Op. site kidney and ureter
1 Hen	Left direct reimplantation	Survived 5 days	Left: Hydronephrosis and hydro-ureter. Orifice not patent. Caked material adherent to projecting end of ureter	Left: Acute pyelonephritis and ureteritis	Right: normal
2 Hen	Right direct reimplantation	Sacrifice 10 days	Right: Hydronephrosis and hydro-ureter. Orifice barely patent	Right: Chronic pyelonephritis and ureteritis	Left: normal
3 Hen	Left direct reimplantation	Sacrifice 12 days	Left: Mild dilatation of renal pelvis and ureter. Orifice patent	Left: No infection	Right: normal
4 Hen	Right direct reimplantation	Sacrifice 12 days	Right: Dilated renal pelvis and ureter. Kidney atrophic. Orifice not patent	Right: Chronic atrophic pyelonephritis and ureteritis. Ureter filled with caked material	Left: normal
5 Rooster	Right direct reimplantation	Sacrifice 4 days	Right: Mild dilatation of renal pelvis and ureter. Ureter barely patent	Right: Chronic atrophic pyelonephritis and ureteritis	Left: normal
6 Hen	Left direct reimplantation	Sacrifice 45 days	Left: Hydronephrosis and hydro-ureter. Orifice patent	Left: Acute pyelonephritis and ureteritis	Right: normal
7 Hen	Left direct reimplantation	Sacrifice 60 days	Left: Hydronephrosis and hydro-ureter. Orifice patent	Left: Chronic pyelonephritis and ureteritis	Right: normal

The clinical picture of death caused by acute uremia was confirmed at necropsy. In every instance there was complete obstruction of the urinary tract as well as an acute bilateral ascending renal infection (Fig. 2) as demonstrated by microscopic sections of the kidneys and ureters. The ureters and renal pelvis were found to be dilated and upon injection of the ureters no fluid could be expressed into the cloaca. In some cases

the obstruction was apparently caused by or contributed to by the presence of caked material which formed around the redundant intra-cloacal end of the ureter.

These universally fatal results made it necessary to resort to unilateral operations in order to study the prolonged effects of ureterocloacal reimplantation. In 7 unilateral direct reimplantations (Table II) and 8 unilateral reimplantations of the intact orifice (Table

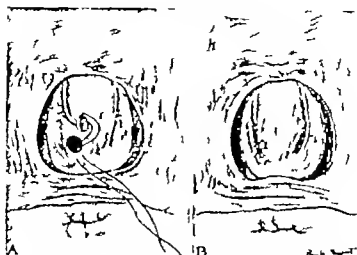


Fig. 2. Ureterocolic reimplantation in the chicken. Method of the intact orifice. A, A circular area of colonic wall bearing the intact ureterocolic orifice has been excised and transfusion suture placed through the periphery. The suture has been passed through the opening made in the cecum and is ready to be anchored short distance beyond. B, Anastomosis completed. The ureter is anchored in place and the opening in the cecum has been closed around the entering ureter.



Fig. 3. Acute ascending pyelonephritis in the chicken. Death 5 days following operation (chicken 2, Table 1).



Fig. 4. Chronic ureteritis in the chicken. Ureter occluded with coagulated material. Sacrificed 5 days following operation (chicken 4, Table 1).

TABLE I—ONE STAGE BILATERAL URETEROCLOACAL REIMPLANTATION IN THE CHICKEN

TABLE I.—ONE SINGLE SURGICAL OPERATION							
No and sex	Operation	Result	Obstruction of urinary tract		Ascending infection		Remarks
			Right	Left	Right	Left	
<i>A Direct reimplantation</i>							
1 Hen	Bilateral direct reimplantation	Died 3 days	Hydronephrosis and hydro-ureter Orifice occluded by caked material projecting into cloaca	Pyonephrosis and pyo-ureter Orifice occluded by caked material projecting into cloaca	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	Infection of wound
2 Rooster	Bilateral direct reimplantation	Died 3 days	Hydronephrosis and hydro-ureter Orifice not patent	Hydronephrosis and hydro-ureter Orifice not patent	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	Peritonitis Infection of wound
3 Hen	Bilateral direct reimplantation	Died 5 days	Hydronephrosis and hydro-ureter Orifice not patent Caked material adherent to projecting end of ureter	Hydronephrosis and hydro-ureter Orifice not patent Caked material adherent to projecting end of ureter	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	
<i>B Reimplantation of intact orifice</i>							
1 Rooster	Bilateral reimplantation of intact orifice	Died 2 days	Hydronephrosis and hydro-ureter Orifice not patent Caked material adherent to projecting end of ureter	Slight dilatation of renal pelvis and ureter Orifice not patent. Caked material adherent to projecting end of ureter	Acute pyelonephritis and ureteritis	Acute pyelonephritis and ureteritis	Peritonitis Infection of wound

TABLE II—UNILATERAL DIRECT URETEROCLOACAL REIMPLANTATION IN THE CHICKEN

No and sex	Operation	Result	Necropsy		
			Obstruction of urinary tract	Ascending infection	Opposite kidney and ureter
1 Hen	Left direct reimplantation	Sacrificed 5 days	Left Hydronephrosis and hydro-ureter Orifice not patent Caked material adherent to projecting end of ureter	Left Acute pyelonephritis and ureteritis	Right normal
2 Hen	Right direct reimplantation	Sacrificed 10 days	Right Hydronephrosis and hydro-ureter Orifice barely patent	Right Chronic pyelonephritis and ureteritis	Left normal
3 Hen	Left direct reimplantation	Sacrificed 22 days	Left Mild dilatation of renal pelvis and ureter Orifice patent	Left No infection	Right normal
4 Hen	Right direct reimplantation	Sacrificed 32 days	Right Dilated renal pelvis and ureter Kidney atrophic Orifice not patent	Right Chronic atrophic pyelonephritis and ureteritis Pelvis and ureter filled with caked material	Left normal
5 Rooster	Right direct reimplantation	Sacrificed 47 days	Right Mild dilatation of renal pelvis and ureter Ureter barely patent	Right Chronic atrophic pyelonephritis and ureteritis	Left normal
6 Hen	Left direct reimplantation	Sacrificed 48 days	Left Hydronephrosis and hydro-ureter Orifice patent	Left Acute pyelonephritis and ureteritis	Right normal
7 Hen	Left direct reimplantation	Sacrificed 60 days	Left Hydronephrosis and hydro-ureter Orifice patent	Left Chronic pyelonephritis and ureteritis	Right normal

The clinical picture of death caused by acute uremia was confirmed at necropsy. In every instance there was complete obstruction of the urinary tract as well as an acute bilateral ascending renal infection (Fig 3), as demonstrated by microscopic sections of the kidneys and ureters. The ureters and renal pelvises were found to be dilated and, upon injection of the ureters, no fluid could be expressed into the cloaca. In some cases

the obstruction was apparently caused by or contributed to by the presence of caked material which formed around the redundant intracloacal end of the ureter.

These universally fatal results made it necessary to resort to unilateral operations in order to study the prolonged effects of ureterocloacal reimplantation. In 7 unilateral direct reimplantations (Table II) and 8 unilateral reimplantations of the intact orifice (Table



Fig. 5. Left hydronephrosis in the chicken. The renal pelvis and ureter are widely dilated. The orifice emits small stream. Chicken sacrificed 32 days following operation. (No. 2, Table III)

III) no death occurred. The chickens were sacrificed at intervals of from 5 to 60 days in order to observe the incidence of obstruction and the presence of infection of the upper urinary tract.

After passing through the phase of complete obstruction of the urinary tract immediately following operation, as well demonstrated in the bilateral series, communication was found to be re-established in many instances. In the 7 direct reimplantations the orifice was well open in 3 instances (No. 3 at 22 days, No. 6 at 48 days, and No. 7 at 60 days). The ori-



Fig. 6. Right hydronephrotic atrophy in the chicken. The kidney shows marked atrophy which is secondary to obstruction and infection. The renal pelvis and ureter are occluded with caked material (see Fig. 5). The orifice not patent. There is compensatory hypertrophy of the left kidney. Sacrificed 32 days following operation (No. 4, Table II)

fice was capable of emitting a small stream in 2 additional instances (No. 2 at 10 days and No. 5 at 47 days). In one chicken (No. 4 at 32 days) the renal pelvis and entire ureter were occluded with caked material (Fig. 4). Of the 8 reimplantations of the intact orifice the opening was patulous in 5 instances (No. 1 at 5 days, No. 2 at 10 days, No. 5 at 21 days, No. 7 at 43 days and No. 8 at 60 days). The effect of obstruction was a dilatation of the ureter and renal pelvis with varying degrees of hydronephrotic atrophy of the renal parenchyma (Figs. 5 and 6).

Whereas acute ascending infection was noted in all of the bilateral reimplantations,

as the time of survival was lengthened beyond 5 days, chronic pyelonephritis and ureteritis became the more usual findings (Fig 7) In 1 of the 7 direct reimplantations (No 3 at 22 days) and in 2 of the 8 reimplantations of the intact orifice (No 5 at 21 days and No 7 at 43 days) no inflammatory changes were found on microscopic examination These findings do not preclude, of course, the occurrence of an early infection with resolution

The incidence of obstruction of the urinary tract and ascending infection by the two methods is tabulated in Table IV It will be noted that the use of the intact orifice was attended with slightly better results than direct reimplantation of the divided ureter Even the former method, however, failed to exhibit any appreciable merit Although the poor results may be partially attributed to the extremely small size of the ureter and the viscid consistency of the urine which, in a few cases, may have predisposed to caking within the ureter, these factors cannot be held entirely responsible in view of the development of a patent orifice in the majority of instances

Summarizing the results of the 23 reimplantations by both methods, changes caused by obstruction of the urinary tract were found in 21 instances, or 91 per cent, and evidence



Fig 7 Photomicrograph of specimen showing chronic ascending pyelonephritis in the chicken The bird was sacrificed 30 days following operation (chicken 6, Table III)

TABLE III--UNILATERAL URETEROCLOACAL REIMPLANTATION OF THE INTACT ORIFICE IN THE CHICKEN

No and sex	Operation	Result	Necropsy		
			Obstruction of urinary tract	Ascending infection	Opposite kidney and ureter
1 Hen	Left intact orifice	Sacrificed 5 days	Left Hydronephrosis and hydro-ureter Orifice patent	Left Mild pyelitis and ureteritis	Right normal
Hen	Left intact orifice	Sacrificed 10 days	Left Hydronephrosis and hydro-ureter Orifice patent	Left Chronic pyelonephritis and ureteritis	Right normal
3 Hen	Right intact orifice	Sacrificed 15 days	Right Hydronephrosis and hydro-ureter Atrophy of kidney Orifice not patent	Right Chronic atrophic pyelonephritis and ureteritis	Left normal
4 Hen	Left intact orifice	Sacrificed 1 days	Left Hydronephrosis and hydro-ureter Orifice not patent	Left Chronic pyelonephritis and ureteritis	Right normal
5 Hen	Right intact orifice	Sacrificed 21 days	Right Hydronephrosis mild hydro-ureter Orifice patent	Right No infection	Left normal
6 Hen	Left intact orifice	Sacrificed 30 days	Left Hydronephrosis and hydro-ureter Orifice occluded by caked material projecting into cloaca	Left Chronic pyelonephritis and ureteritis	Right normal
Hen	Right intact orifice	Sacrificed 43 days	Right No hydronephrosis or hydro-ureter Orifice patent	Right No infection	Left normal
8 Hen	Left intact orifice	Sacrificed 60 days	Left Hydronephrosis and hydro-ureter Orifice patent	Left Chronic pyelonephritis and ureteritis	Right normal

TABLE IV.—INCIDENCE OF ASCENDING URINARY TRACT INFECTION AND OBSTRUCTION FOLLOWING URETEROCOCAECAL REIMPLANTATION IN THE CHICKEN

	Direct method	Method of intact ureters	Total
Number of implants	5		5
Number showing obstructive changes	3	8	
Percentage of obstructive changes	60	80	9
Number showing complete occlusion of orifice	8	5	3
Percentage of complete occlusion of orifice	62	50	57
Number showing infection		8	20
Percentage of infection	92	80	87

*Chicken 5 of unilateral series, showing only mild infection of the ureter, not included.

of ascending infection was found in 20 instances, or 87 per cent.

These results are certainly no better than those following uretero-intestinal anastomosis. They furnish proof that

1 The urinary tract of the chicken is readily susceptible to obstruction and ascending infection. No natural immunity exists, nor do the peculiarities of structure which have been described deter against infection or obstruction.

2 Obstruction of the urinary tract and ascending infection incident to ureterocolic reimplantation are caused by changes induced at operation, it being evident that the undisturbed relationship of the ureters entering the cloaca is compatible with a normal urinary tract.

3 The critical period of ureterocolic reimplantation as in uretero-intestinal anastomosis, is during the first few days after operation when there is a phase of urinary obstruction and acute ascending infection. If this stage is surmounted a re-establishment of a freer urinary flow and a certain degree of subsidence in renal infection may be anticipated. This factor explains the better results obtained following a two stage operation as compared to those of a one stage bilateral implantation.

The problem of ureterocolic reimplantation therefore, presents no particular features apart from those of uretero-intestinal anastomosis. With the results of the ureterocolic operation equally as poor as those

attending uretero-intestinal implantation, one can safely conclude that operative trauma and the opening of tissue spaces in a contaminated field set off the sequence of events which lead to obstruction and ascending infection.

It is important to appreciate the close interrelationship between urinary obstruction and ascending infection. Acute pyelonephritis and ureteritis were present in all the chickens observed within the 5 day post operative period in which there was complete occlusion of the orifice (9 reimplantations). In the one instance of a patent orifice in this group (No. 1 Table III) a mild pyelitis and ureteritis demonstrated the only inflammatory reaction. Furthermore, in the only three urinary tracts of the entire series which failed to yield evidence of infection following operation (Nos. 3 Table II Nos. 5 and 7 Table III) patent orifices were present and little or no dilatation of the ureters and of the renal pelvis existed.

SUMMARY

Some reptiles and all birds possess ureters which normally open into a cloaca. Although the cloaca contains numerous pathogenic organisms, spontaneous ascending infection does not occur. The present study was carried out in order to determine whether certain peculiarities of anatomical structure or natural resistance provide these animals with an immunity to infection of the urinary tract. If such were the case ureterocolic reimplantation should be an innocuous procedure. This operation was performed, therefore in 19 chickens. In 4 bilateral and 15 unilateral ureterocolic reimplantations, making a total of 23 reimplantations in all, obstruction of the urinary tract occurred in 91 per cent and ascending infection in 87 per cent of the cases. These findings indicate the following points:

The urinary tract of the chicken is readily susceptible to obstruction and ascending infection.

2 Obstruction of the urinary tract and ascending infection incident to ureterocolic reimplantation are caused by changes induced at operation.

The problem of ureterocloacal reimplantation, therefore, presents no peculiar features apart from those of uretero-intestinal anastomosis. Operative trauma and the opening of tissue spaces in a contaminated field set off the sequence of events which lead to obstruction and ascending infection. In order to duplicate consistently the normal ana-

tomical arrangement of the ureterocloacal entrance by surgical means, whether in the case of the chicken or of the higher mammals, these complications still remain to be conquered.

We wish to express our appreciation to Dr. Richard A. Peterfy for his assistance in carrying out the experiments reported in this paper.

URETERAL AND RENAL COMPLICATIONS OF CARCINOMA OF THE CERVIX

Their Classification and Management

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THE purpose of this communication is to suggest a method of improving the 5 year end-results in patients with cancer of the cervix by (1) complete urological investigation before institution of radiation therapy and (2) prompt urological management of the ureteral and renal complications which occur either as a direct result of the tumor or as a complication of irradiation.

Within recent years comprehensive studies have been reported from this clinic (4, 5) based upon 390 cases of carcinoma of the cervix, with reference to the urological changes which were shown commonly to accompany this disease. The high incidence of ureteral occlusion was particularly stressed and obstruction of one or both ureters was found in 70 per cent of these cases.

There are also clinical (2, 7, 11), experimental (8, 9) and postmortem (1, 3) studies in the literature which add further emphasis to the importance of the subject.

It is obvious that many complications arise when the tumor encroaches upon or invades one or both ureters. The encroachment results in hydro-ureters, hydronephrosis or pyonephrosis, and even death from uremia because of impaired renal function. It is doubtful in the more advanced cases, whether the 5 year survivals can be increased even with the best form of irradiation and urological treatment. However a large number of the less advanced cases (Class C—extension to broad ligaments) also die of uremia, either before irradiation has had an opportunity to affect the neoplasm, or after it has been successful in eradicating the malignant disease. It is especially upon this

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group that our attention is focused. We believe that early recognition and treatment of the upper urinary tract complications should increase the 5 year salvage.

The importance of pre-irradiation urological study in patients with cancer of the uterine cervix has been emphasized in previous communications from this clinic (4, 5). The studies should include (1) a careful history and physical examination, (2) complete laboratory tests of renal function, (3) cystoscopy and ureteral catheterization when possible, and (4) retrograde and intravenous urograms. Only through early investigation can these complications be recognized and treated promptly.

Postirradiation urological study should be carried out when the patient has symptoms and signs referable to the upper urinary tract. These patients may be cured of their malignant disease but they will die of renal insufficiency if their urinary tract complications go unrecognized and untreated.

Prompt treatment of ureteral occlusion will often give the patient marked relief from pain, fever and the distressing symptoms of renal insufficiency. The general condition of the patient may be a factor in determining the response of the growth to radiation therapy. Drainage of the obstructed kidney and ureter may prevent irreparable damage to these organs and provide the patient with a greater margin of safety should the previously unaffected kidney and ureter later become occluded by disease, infection or fibrosis.

The type of urological treatment and the time of its application should depend on (1) the age and general condition of the patient, (2) prognosis for cure and (3) urgency for the relief of distressing symptoms (pain, fever, toxemia). The patient may require only cysto-

scopic treatment with ureteral dilatation. If a nephrostomy should be necessary, the procedure can be carried out with little risk, usually under regional anesthesia. There has been no primary mortality with this operation in our clinic. Postoperative convalescence is usually smooth and often the patient experiences prompt relief.

There are definite indications for neurosurgical relief of pain in advanced cancer of the cervix, but it is essential to exclude the upper urinary tract as the offender. When pain is caused by ureteral occlusion, it is more logical to drain the involved ureter and kidney than to mask the symptoms with opiates, intraspinal alcohol injections, or chordotomy.

UROLOGICAL CLASSIFICATION

The cases showing upper urinary tract complications have been divided into three "urological" groups as follows: Group I—ureteral obstruction before or during treatment, Group II—ureteral obstruction months or years after treatment with no clinical evidence of residual malignant disease, Group III—ureteral obstruction months or years after treatment, with persistent disease. If the ureteral and renal complication is present before or during radiation therapy the case is classified as belonging to Group I. Group II cases include those with ureteral and renal complications developing a number of months or years after the completion of x-ray and radium treatment. These patients have no clinical evidence of residual malignant disease. If the upper urinary tract complication occurs months or years after radiation, but the patient still shows evidence of persistent neoplasm, the case is classified as Group III.

This division of cases is necessary because the indications for urologic management vary with each group. The type of urologic treatment also depends on the prognosis for cure, the life expectancy of the patient, her general state and the urgency for relief of symptoms.

When pre-irradiation urologic study discloses ureteral obstruction (Group I) cystoscopic dilatation of the obstructed ureter should be attempted. If this procedure fails to provide adequate drainage, nephrostomy must then be considered. In selecting a case

for nephrostomy the urologist should be guided by the age of the patient (life expectancy) and prognosis for cure. Sometimes nephrostomy is indicated for the relief of pain, fever, or toxemia in spite of advanced malignant disease.

Early urologic treatment improves the general condition of the patient so that she is better able to tolerate the radiation program. Partial ureteral obstruction if present before the onset of irradiation, and if not treated urologically, may become complete by the radiation edema which occurs in the tumor or the ureteral wall itself. If the urinary complication is managed early the patient may survive her irradiation with minimal renal damage.

Immediate urologic management is indicated for patients in Group II. These patients "cured" of their malignant disease may die of renal impairment if the ureteral and renal complications go untreated. Since the obstruction of the ureter has occurred months after radiotherapy, it may be assumed that this is due to postirradiation or replacement fibrosis. It has been possible in many of these cases to drain the obstructed ureters successfully by cystoscopic dilatation at repeated intervals. This group is the most important one because almost all of these patients can be saved if their urological complication is recognized promptly and treated early. Sometimes these patients are not referred back to the clinic but are treated at home by their local physician. He may erroneously assume that they are suffering from recurrent malignant disease and therefore give them sufficient opiate to mask their symptoms until they die of renal insufficiency.

Urologic management is less urgent for patients in Group III because the prognosis for cure is almost nil. Treatment may be necessary for relief of pain, sepsis, or terminal uremic symptoms. A surprising number in this group will live many months following palliative urological treatment in a fair degree of comfort.

The 25 cases with proved ureteral and renal complications reported in this study were found in a group of 70 patients with cancer of the cervix treated at the Pondville Hos-

TABLE I.—INCIDENCE OF UPPER URINARY TRACT COMPLICATIONS IN 70 TREATED CASES OF CANCER OF THE CERVIX

	Number	Per cent	Clinical class			
			A	B	C	D
Total cases	70	100	5	3	45	7
Proved ureteral obstruction	5	35.7			9	6

TABLE II.—PROVED URETERAL OBSTRUCTION—DISTRIBUTION ACCORDING TO GROUP AND EXTENT OF DISEASE

Group	Number	Per cent	A	Clinical class	C	D	Living 5 years
				B			
I.	5	52			8	5	
II.		8					
III.		40			9		

pital and followed for 5 or more years (10). The incidence of this complication therefore is 35.7 per cent for the group (Table I). There were no clinical class A or B cases with proved ureteral obstruction. This fact is important because it may indicate that the obstruction is not due to radiation effect on the ureteral wall. It may be due to a tumor tissue edema during treatment or a replacement fibrosis after treatment in those cases in which the disease extends out into the broad ligaments. There were 19 C cases and 6 D cases. Thirteen cases, or 52 per cent, of the group showing this complication, developed upper urinary tract obstruction before the onset of treatment (Group I). Two patients, or 8 per cent, first showed ureteral occlusion months after the end of their treatment and had no clinical evidence of residual cancer (Group II). Ten patients, or 40 per cent, had upper urinary tract complications months after treatment, but still had residual disease (Group III). Of the total number with urinary complications only 5 received urologic treatment. Two of these patients are alive and well after a period of 5 years and 3 of them are dead. Both of the living patients developed signs and symptoms of ureteral occlusion many months after the completion of their radiation therapy and presented no evidence of residual malignant disease (Group II—Table II).

TABLE III.—PROVED URETERAL OBSTRUCTION—24 CASES

Group	Time of onset of obstruction		Ureteral treatment		No. of cases treated		Average duration of obstruction (months)	
	X	Y	D	L	L	D	X	Y
I	3	5					4	5
II		3					6	5
III	10	40	9	9	9	9	80	80
Totals	5	100	5	3	90	90	42	16

ANALYSIS OF CASES WITH URETERAL AND RENAL COMPLICATIONS

The 25 cases of proved ureteral obstruction, divided according to their respective urologic groups, are further analyzed in Table III.

Group I. Thirteen, or 52 per cent of 25 patients, showed ureteral obstruction before or during x-ray and radium treatment. There were no Class A or B cases. Eight patients were in Class C, and 5 in Class D.

Study. All but 1 of these 13 patients complained of pain varying from 1 to 14 months' duration, or an average of 4 months, before the onset of treatment. The character of the pain varied from a dull ache to a sharp lancinating type, the former being the more common. It occurred either in one or both flanks, and if unilateral it corresponded to the side of the involved ureter or kidney. Occasionally the pain radiated down to the crest of the ilium or to the hip on the involved side. Sometimes it had a sciatic distribution down the posterior aspect of the thigh to the knee. Occasionally the patient stated that the pain was referred to the groin or vulva. A number of patients complained of "low abdominal cramps" and others of "low back pain." One patient had severe pain in the right lower quadrant and had an appendectomy before admission. This patient continued to have the same type of discomfort after her operation and subsequently proved to have a right hydro-ureter and right hydronephrosis complicating a cervical cancer. In the majority the location of the pain and the involvement of the ureter corresponded to the side which by clinical examination showed broad ligament involvement. Postmortem examination revealed the involved ureter to be on the same side as the pain.

Blood chemistry estimation of total non-protein nitrogen retention showed the level to

remain within normal limits in all but 1 case until the late stages of renal destruction. In 1 patient it rose to 250 milligrams per 100 cubic centimeters. The routine 2 hour test of renal function with phenolsulfonphthalein was a much better test for early renal insufficiency. Intravenous pyelography was useful in those cases in which ureteral catheterization proved impossible. Retrograde pyelography was more accurate in determining the degree of hydronephrosis. Obstruction within the ureter was met usually at a point 4 to 6 centimeters above the ureteral orifice.

Two patients in this group were examined postmortem. One had a blocked ureter on the left side with hydro-ureter and hydronephrosis, and a right pyelitis and ureteritis. The other showed both ureters blocked by disease.

Treatment Many of the patients included in this study entered the hospital before complete urological investigation and prompt management became a routine procedure. As a consequence, 4 patients in Group I were not seen by the Urological Service. One patient who was investigated refused nephrectomy. One patient had a ureterostomy performed after the first day of treatment because of chills, fever, and renal pain. Radiation treatment was resumed 10 days after operation without subsequent exacerbation of symptoms. She was sent home with a ureterostomy tube in place. She was free of disease clinically and did well for 1 year and 7 months until her local physician removed the ureterostomy tube because he thought she could get along without it. She soon complained of costo-vertebral pain and died 4 months later with evidence of terminal uremia. One patient treated by ureteral dilatation lived 5 years and 3 months, and died of recurrent disease with ureteral occlusion. One patient who had no urological investigation was seen by the Neurosurgical Service, and had four alcohol injections and two chordotomies in an attempt to relieve her pain. Postmortem study showed bilateral renal and ureteral involvement (see case report). Five other patients were either studied incompletely from the urologic standpoint or had treatment deferred until renal damage was beyond recovery.

The average duration of life in the group that had no urologic treatment was 12 months, while the group which had urologic therapy lived an average duration of 41 months from the onset of the treatment.

Group II Two patients, or 8 per cent, showed *ureteral obstruction after completion of treatment with no clinical evidence of residual disease*. Both of these patients were in clinical Class C.

Study One patient complained of pain in both flanks 21 months after radiation therapy. The other had pain in the left flank radiating toward the groin 7 months after treatment. Because there were only 2 patients in this group we cannot draw definite conclusions. However, it is interesting to note that the appearance of symptoms averaged 14 months for Group II as compared to 4 months for those patients in Group I. The delayed appearance of symptoms may be due to the slowly constricting scar tissue which forms about the lower ureter. The cicatrization may be a direct result of irradiation or a "replacement" fibrosis. Again the pain and ureteral occlusion occurred on the side that also showed clinical broad ligament involvement.

Blood chemistry determinations were not significant. One patient had a normal bilateral intravenous pyelogram but demonstrated bilateral hydro-ureters and hydronephroses on retrograde pyelography. Retrograde pyelography showed that the other patient had definite evidence of ureteral stricture on one side.

Treatment Both patients had prompt urologic treatment consisting of ureteral dilatation. This procedure was repeated at successive intervals and proved to be sufficient in each case.

The value of prompt management is evident as both patients are alive and well, one 5 years and 8 months, and the other 6 years after treatment.

Group III Ten patients, or 40 per cent, showed evidence of *ureteral obstruction developing after completion of treatment and with positive evidence of residual disease*. Nine had evidence of extension of the disease into one or both broad ligaments (Class C). One patient had remote metastases (Class D).

Study All patients in this group complained of pain. The duration varied from 5 months to 17 months, the average being 9½ months. In all but 2 instances the location of the pain corresponded to the side of the ureteral pathology and likewise to the side that had broad ligament extension.

A review of the findings shows that intravenous and retrograde pyelograms were more dependable tests of renal damage than the blood chemistry estimation of total non-protein nitrogen.

Treatment Only 1 patient in this group received urologic treatment. This consisted of ureteral dilatation on one occasion. She lived 1 year and 8 months and died of uremia. Two patients required such large doses of opiate for relief of pain that they subsequently became morphine addicts.

The average duration of life in this group was 20 months. There were 5 postmortem studies and all proved that death was due to renal impairment from obstructed ureters. In a number of these patients there was considerable fibrosis noted about the ureters.

TREATMENT BASED ON COMPLETE UROLOGIC EXAMINATION

It is now routine practice in this clinic to carry out complete urologic investigation before treatment is given for carcinoma of the uterine cervix. A careful history is extremely important to detect symptoms which may suggest ureteral occlusion.

Ureteral stricture produces a nagging type of discomfort or sharp pain at or near the site of occlusion or in the renal area on the affected side. The pain was nearly always present on the same side as the broad ligament extension of the disease. Radiation of pain occurred upward toward the kidney laterally into the hip or groin, or posteriorly into the thigh or leg. The pain was either intermittent or constant. When pain occurs as a symptom in cancer of the uterine cervix it may be due to extension of the disease or may be caused by a complication of the treatment. Skeletal involvement can usually be proved by roentgen examination. Stenosis of the cervical canal with associated pyometrium may be determined by probing the uterine canal. Pelvic peritonitis

if present presents the usual signs and symptoms commonly associated with any peritonitis. One may therefore in a differential diagnosis strongly suspect a stricture of the ureter if the other causes of pain as outlined above are excluded.

It is not the purpose of this paper to prove or disprove the theory that ureters may be occluded as a result of radiation therapy alone. A number of authors have reported their clinical (3, 4, 5, 7, 11) and laboratory (8, 9) experience which points to the fact that post-irradiation fibrosis does occur. We have observed ureteral occlusion following divided doses of x-ray alone (400 r per day to one of four pelvic portals 8 by 10 centimeters each, alternating fields daily: two anterior and two posterior fields, 50 centimeters focal skin distance, ½ millimeter copper and 1 millimeter aluminum filter. Total of 1200 r to each of the anterior portals and 800 r to each of the posterior portals, grand total of 4000 r in 10 treatments). This obstruction probably resulted from radiation edema. We have also seen ureteral obstruction clinically and at postmortem examination (12) many months after treatment, with and without the presence of gross residual neoplasm. This obstruction in some instances seemed to be due to fibrosis. Whether it is a "replacement" fibrosis or an actual radiation fibrosis is difficult to state. Its less frequent occurrence, clinically in the A and B cases would argue against the latter.

Complete physical examination is made especially with regard to renal enlargement or tenderness. Graves and Milhizer have emphasized the fact that advanced kidney damage may occur without local signs and symptoms. Therefore one must study the patient still further to complete the urological examination.

Blood nitrogen studies are carried out, but cannot be relied upon for early evidence of impaired renal function. In our series, the elevated non-protein nitrogen was usually a terminal finding. The renal function test with phthalein was a much better test for early renal insufficiency. Routine cystoscopy and ureteral catheterization gave important information concerning the presence or absence of bladder invasion and especially the degree

of patency of the ureters The divided test of renal function with intravenous phthalein is employed, and when the ureters are not identified or when catheters cannot be passed, indigocarmine is used

Retrograde and intravenous pyelograms complete the study of the upper urinary tract It is important to remember that patients with relatively normal intravenous pyelograms may show definite obstructive changes in the ureters and kidney, by retrograde pyelography

It is important to relieve the obstructed ureter at once, preferably before radiation therapy is started This should be done by ureteral dilatation if possible Occasionally the patient may be treated with an indwelling ureteral catheter, following gentle dilatation If the degree of hydro-ureter and hydro-nephrosis is great, nephrostomy must be considered This of course is limited to those patients who still show residual function in the affected kidney If the patient is relieved of her disease and ureteral patency is re-established after treatment, it is still possible to remove the nephrostomy tube and allow the fistula to close spontaneously

Nephrectomy is reserved for the infected and functionless kidney which is causing chills, fever, and toxemia in cases in which the condition of the patient and the state of the other kidney warrant this operation

When the prognosis is questionable or positively hopeless (advanced or Class D cases), treatment should be symptomatic and palliative only

Patients who present themselves months or years after radiation treatment with the complaint of backache, pain in the lower abdomen, hip, groin, vulva, or leg, showing no evidence of residual neoplastic disease (Group II) require careful search for ureteral obstruction If a positive diagnosis is established, ureteral dilatation may be attempted when the affected kidney still retains its function If this fails the patient should have a nephrostomy or nephrectomy Should obstruction be complete and the kidney functionless and silent, nothing need be done, except careful observation at relatively frequent intervals with reference to the other kidney The patient should

be instructed always to return immediately on the occasion of pain, chills, or fever These symptoms may signal the onset of infection in the previously unaffected kidney Immediate measures should be taken to prevent complete anuria and uremia It is sometimes necessary to do a nephrostomy upon the previously unaffected but now infected kidney in order to save the patient's life On the other hand, the previously silent kidney may be the cause of the patient's symptoms, and if so nephrectomy should be performed

Those patients showing ureteral stricture months or years following radiation but who still have evidence of recurrent or residual disease (Group III) may require palliative treatment to the involved upper urinary tract Usually it is not possible to relieve the ureteral obstruction by dilatation from below, because the persisting disease does not permit dilatation More radical measures, such as nephrostomy or nephrectomy, should be limited to those patients showing evidence of uremia or severe toxemia due to upper urinary tract infection

CONCLUSIONS

- 1 The importance of urologic investigation before treating cancer of the cervix by radiation is re-emphasized

- 2 A classification of the cases according to the development of ureteral obstruction before, during, or after treatment, with or without the presence of local disease, is presented

- 3 The need for prompt urologic management is suggested, once the diagnosis has been established The type of urologic treatment selected should depend on the state of the local disease and the general condition of the patient

- 4 An analysis of a group of 70 cases followed 5 years after treatment shows an incidence of 35.7 per cent of proved ureteral obstruction Those patients having prompt, adequate urologic treatment showed good end-results Those patients not treated died from uremia

- 5 Improvement of 5 year end-results may be expected if this large group showing ureteral and renal complications is treated promptly If death from renal impairment is prevented, a larger percentage of those developing ure-

teral occlusion before or during radiation therapy may live long enough to obtain the maximum effect of their treatment. The Group II cases should all do well if the complication is recognized and treated early. Life may be prolonged in the Group III cases and these patients may be spared the distressing symptoms of terminal uremia.

6 Carcinoma of the cervix is a combined system disease, requiring the attention of the gynecologist, urologist, and radiologist.

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MALIGNANT TUMORS OF THE THYROID GLAND

Report of 200 Consecutive Cases

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THIS study of malignant tumors of the thyroid gland is based upon 200 consecutive cases in which clinical and microscopic diagnoses were made by Dr George Crile and associates of the Cleveland Clinic Foundation between 1922 and 1933, inclusive. This period of time was selected because deep roentgen therapy was instituted at the clinic in 1922 before which time the treatment was quite empirical or definitely experimental. In addition, a 5 year period has elapsed since 1933. This series includes approximately one-half of the cases of malignant tumors of the thyroid observed prior to 1922 and after 1933. All the cases have been studied from the standpoint of pathology by Dr Allen Graham.

The series was first classified on the basis of the different types of histopathology according to the plan originally advocated by Dr Graham in 1925 and outlined in Table I.

TABLE I—HISTOLOGICAL CLASSIFICATION OF MALIGNANT TUMORS OF THYROID

- I Carcinomas originating in pre existing adenomas
 - A Malignant adenomas
 - B Papillary carcinomas
- II Carcinomas without evidence of having originated in pre existing adenomas
 - A Adenocarcinomas
 - B Scirrhus carcinomas
- III Mixed type
 - Carcinoma-sarcoma
- IV Sarcomas
 - A Lymphosarcoma
 - B Fibrosarcoma
 - C Other types

The tumors to which Dr Graham applied the name "malignant" adenomas possess no characteristic histology. They originate in pre-existing adenomas, therefore they present the histology of fetal, intermediate, or mixed colloid adenomatous structure and any one,

From the Cleveland Clinic.

two, or even all these transitional types may be found in a single tumor, in fact, it is seldom that only one is found. Therefore, a malignant adenoma may present the morphological characteristic of any one or more of the forms: adenocarcinoma, medullary carcinoma, scirrhus carcinoma, papillary carcinoma (not papillary cystadenoma), or carcinoma resembling sarcoma. Because of this diversified variability in the structure of these tumors, it is sometimes difficult to differentiate or classify them only on a histological basis, therefore it is necessary to study the gland as a whole, its probable involutional changes, the type of structure of the pre-existing adenoma in which neoplasia began, as well as its duration, rate of growth, and stroma reaction. The outstanding characteristic of malignant adenomas is the invasion of the blood vessels in which there may be thrombi or intravascular polypi with the same morphological characteristics as are found in the parent tumor. This invasion of the blood vessels does not occur with other types of thyroid tumors which extend into the lymphatics.

The "papillary carcinomas" are primarily localized, encapsulated neoplasms with characteristic papillary morphology. Sometimes cells in papillary tumors may break through the thin stroma at the base of the acini and invade and extend into surrounding structures whereupon the neoplasms may be considered malignant. The lateral labyrinth or aberrant thyroid tumors with papillary structure, which may be found outside or within the thyroid capsule, are not and should not be included among malignant tumors of the thyroid *per se*. They are seldom malignant and they do not recur if completely removed, but others may develop in the embryonic tract or lateral labyrinth from which the primary growth originated.

The adenocarcinomas not known to originate in pre-existing adenomas, *adenocarcinomas not in adenoma*, apparently begin in acinar epithelium. The tumor is found as a small, definitely localized, although non-encapsulated growth, of very low grade malignancy. The subsequent course or development of this neoplasm is unknown. They are discovered only by the pathologist and produce no clinical signs.

The scirrhous carcinomas have the same origin and histological characteristics as scirrhous tumors which are found in other glandular organs. Fibrous tissue predominates and the neoplastic epithelial cells occur in masses or strands. It cannot be proved that these tumors begin in pre-existing adenomas although possibly they may do so. They are not encapsulated and they invade and surround neighboring structures quite rapidly by permeation through the lymphatics.

The carcinoma-sarcomas, those tumors with complex morphology contain both epithelial and mesothelial malignant elements. They invade the lymphatics, and their clinical course is similar to that of scirrhous carcinomas.

Sarcomas of the thyroid are comparatively rare. In many reports in the literature they apparently have been confused often with malignant adenomas and vice versa. Some pathologists do not agree that sarcomas occur in the thyroid and call them round cell carcinomas. Yet there is no reason why the abundant mesothelial elements in the thyroid especially the lymphoid tissue and stroma, might not occasionally undergo malignant degeneration to produce sarcomas. The lympho-sarcomas and "fibrosarcomas" of the thyroid have the same histopathology as the same types of tumors found in other locations.

In addition to the pathological classification of the malignant tumors these cases have been grouped also according to the extent of disease found in each clinically at operation or by the pathologist's examination. Such a grouping is advisable in order to make equitable statistical comparisons between different methods of treatment. In a great many reports in the literature about the results obtained by

different therapeutic procedures for different types of malignant neoplasms, and in which all cases are included in one category whether in early or late stages, it is often obvious that there was a disproportion between the early and advanced cases in the series used for comparison. This is especially apparent when the results of operation alone and of radiological procedures are compared, because it is usually when the disease is more advanced that irradiation is given. Statistical comparisons based upon inequalities in the types of cases treated by different methods lead to erroneous conclusions. Therefore, in this study the results will be shown on the basis of the different histological types of tumors found and also on the basis of a plan for grouping cases according to the extent of disease. The plan which will be employed in this study is based upon the criteria presented in Table II.

TABLE II.—A PLAN FOR GROUPING MALIGNANT TUMORS OF THYROID ACCORDING TO EXTENT OF DISEASE.

Group I. Cases without clinical evidence of malignant tumor which was discovered only after microscopic examination and the tumor was only a few millimeters in diameter.

Group II. Cases without clinical evidence of malignant tumor, or its presence was suspected only on the basis of history of rapid enlargement of the thyroid gland, or discovered at operation and the growth was still localized within the thyroid capsule.

Group III. Cases with clinical evidence of malignant tumor which had invaded or extended outside of the thyroid capsule to neighboring or distant structures.

The series of 200 consecutive cases, classified and grouped according to this plan and also according to histopathology is shown in Table III. The primary cases are those in which no treatment was given prior to admission to the clinic. The recurrent cases are those in which local recurrence followed operations prior to admission. The cases having no treatment comprise those patients who presented themselves without having had any previous treatment and were in such advanced stages of the disease that treatment was not justifiable, and also a few patients who refused treatment at the clinic after a clinical diagnosis had been made and treatment advised. The cases listed as unclassified are

TABLE III—ALL CASES CLASSIFIED AND GROUPED

Pathological classification	Primary cases					Recurrent cases	Total cases	Per cent of all cases
	G I	G II	G III	Total	Per cent			
Malignant adenoma	2	19	45	66	53.2	7	73	54.8
Papillary carcinoma	7	11	3	21	17.0	1	22	16.5
Adenocarcinoma not in adenoma	19			19	15.3		19	14.3
Scirrhus carcinoma			3	3			3	
Carcinoma sarcoma			1	1			1	
Lympho-sarcoma			11	11	9.0		11	8.2
Fibrosarcoma			2	2		1	3	
Myxo-sarcoma			1	1			1	
Classification unknown	29	30	66	124	62.0	0	123	65.0
Unclassifiable			14	14		1	15	10.1
Classifiable			80	138	60.0	10	148	74.0
Unknown pathology			46	46	25.0	1	52	26.0
Total Cases	28	30	126	184		16	200	

those with positive microscopic evidence of a malignant tumor but the type could not definitely be determined. No microscopic examination was done in the cases listed as "unknown pathology" as these were in such advanced stages that biopsy even to appease scientific curiosity was not justifiable.

The incidence of occurrence of different tumors is shown in Table III. This shows that of a total of 133 primary and 9 recurrent cases, that could be classified on the basis of histology, there were 73 malignant adenomas, or 54.8 per cent, which is more than one-half of the 148 classifiable tumors. The next largest type are the papillary carcinomas, or 16.5 per cent. Thus a total of 95 tumors or over 70 per cent in the series can be proved to have originated in pre-existing adenomas. This incidence supports Dr. Graham's contention that a large percentage of all malignant tumors of the thyroid originate in pre-existing adenomas. The third largest group is made up of the adenocarcinomas not in adenomas which are histologically malignant but clinically benign. The lymphosarcomas were not uncommon, 8.2 per cent, but only a few of the scirrhus carcinomas, carcinoma-sarcoma, and other rare types were met.

According to the plan adopted for grouping (Table III), 28 of the total 184 primary cases fell into Group I, or 15.2 per cent, 30 fell into

Group II, or 16.3 per cent, and 126 fell into Group III, or 68.5 per cent. This indicates that two-thirds of the patients with malignant tumors of the thyroid were in advanced stages of the disease when first seen and, as will be shown, were incurable by operation alone.

The early or Group I cases comprise only 2 malignant adenomas, the remainder being papillary carcinomas and adenocarcinomas not in adenomas, which were not even suspected by clinical examination or at operation performed primarily for other thyroid disturbances, but the malignant tumor was subsequently discovered by the pathologist.

Group II, composed of moderately early cases, is made up exclusively of malignant adenomas and papillary carcinomas which apparently had not yet invaded to any great extent outside the primary adenoma and not at all outside the thyroid capsule as observed clinically, at operation, or after pathological examination.

Group III comprises the most advanced cases with tumors invading outside the thyroid capsule. Forty-five, or 68.2 per cent of this group, were malignant adenomas. All the other types of tumors, except the adenocarcinoma not in adenoma, fall into this advanced group. All the cases in which no microscopic examinations were made because of the extent of the disease, of course, fall into Group III.

The adenocarcinomas not known to originate in pre-existing adenomas *adenocarcinomas not in adenoma*, apparently begun in acinar epithelium. The tumor is found as a small definitely localized, although non-encapsulated growth, of very low grade malignancy. The subsequent course or development of this neoplasm is unknown. They are discovered only by the pathologist and produce no clinical signs.

The "scirrhous carcinomas" have the same origin and histological characteristics as scirrhous tumors which are found in other glandular organs. Fibrous tissue predominates and the neoplastic epithelial cells occur in masses or strands. It cannot be proved that these tumors begin in pre-existing adenomas although possibly they may do so. They are not encapsulated and they invade and surround neighboring structures quite rapidly by permeation through the lymphatics.

The "carcinoma-sarcomas," those tumors with complex morphology contain both epithelial and mesothelial malignant elements. They invade the lymphatics, and their clinical course is similar to that of scirrhous carcinomas.

Sarcomas of the thyroid are comparatively rare. In many reports in the literature they apparently have been confused often with malignant adenomas and vice versa. Some pathologists do not agree that sarcomas occur in the thyroid and call them round cell carcinomas. Yet there is no reason why the abundant mesothelial elements in the thyroid especially the lymphoid tissue and stroma, might not occasionally undergo malignant degeneration to produce sarcomas. The "lympho-sarcomas" and fibrosarcomas of the thyroid have the same histopathology as the same types of tumors found in other locations.

In addition to the pathological classification of the malignant tumors these cases have been grouped also according to the extent of disease found in each clinically, at operation, or by the pathologist's examination. Such a grouping is advisable in order to make equitable statistical comparisons between different methods of treatment. In a great many reports in the literature about the results obtained by

different therapeutic procedures for different types of malignant neoplasms, and in which all cases are included in one category whether in early or late stages, it is often obvious that there was a disproportion between the early and advanced cases in the series used for comparison. This is especially apparent when the results of operation alone and of radiological procedures are compared, because it is usually when the disease is more advanced that irradiation is given. Statistical comparisons based upon inequalities in the types of cases treated by different methods lead to erroneous conclusions. Therefore, in this study the results will be shown on the basis of the different histological types of tumors found and also on the basis of a plan for grouping cases according to the extent of disease. The plan which will be employed in this study is based upon the criteria presented in Table II.

TABLE II.—A PLAN FOR GROUPING MALIGNANT TUMORS OF THYROID ACCORDING TO EXTENT OF DISEASE.

Group I. Cases without clinical evidence of malignant tumor which was discovered only after microscopic examination and the tumor was only few millimeters in diameter.

Group II. Cases without clinical evidence of malignant tumor, or its presence was suspected only on the basis of history of rapid enlargement of the thyroid gland, or discovered at operation and the growth was still localized within the thyroid capsule.

Group III. Cases with clinical evidence of malignant tumor which had invaded or extended outside of the thyroid capsule to neighboring or distant structures.

The series of 200 consecutive cases, classified and grouped according to this plan and also according to histopathology is shown in Table III. The primary cases are those in which no treatment was given prior to admission to the clinic. The recurrent cases are those in which local recurrence followed operations prior to admission. The cases having no treatment comprise those patients who presented themselves without having had any previous treatment and were in such advanced stages of the disease that treatment was not justifiable, and also a few patients who refused treatment at the clinic after a clinical diagnosis had been made and treatment advised. The cases listed as unclassified are

TABLE V—SUMMARY OF RESULTS IN ALL PRIMARY CASES ACCORDING TO CLASSIFICATION

Pathological classification	Total cases	Operative mortality	No of known living					
			1 yr	2 yr	3 yr	4 yr	5 yr	5+ yr
Malignant adenoma	73	10	37	32	27	22	19	10
Papillary carcinoma	22	0	19	17	15	14	13	12
Adenocarcinoma not adenoma	19	0	16	15	14	14	14	13
Scirrhous carcinoma	3	2	0	0	0	0	0	0
Carcinoma-sarcoma	1	0	1	0	0	0	0	0
Lymphosarcoma	11	1	3	3	3	3	3	3
Fibrosarcoma	3	0	1	1	1	1	1	1
Myxosarcoma	1	0	1	1	0	0	0	0
Unclassified	15	3	5	2	2	2	2	2
Unknown pathology	52	1	9	5	2	1	1	1
Total	200	17	92	76	64	57	53	41
Lost trace	34		20	23	27	31	35	34
Dead not of carcinoma	8		2	3	4	5	5	8
Dead of carcinoma	117	17	86	98	105	107	109	117

The results obtained in all the different types of tumors by all therapeutic procedures are shown in Table V. Although it would appear that the malignant adenomas present a fairly favorable prognosis, it should be recalled that only about one-third of them were in the early Groups I and II. However, as will be shown later (Table VI), not one of the patients with this type of tumor in the advanced stages (Group III) having operation alone, was known to be living at the end of one year. The papillary carcinomas are shown to have a considerably better prognosis since over one-half of these patients lived 5 or more years but also only 2 of 22 cases with papillary carcinomas were placed in the unfavorable advanced Group III. The tiny adenocarcinomas not in adenomas give the very best prognosis. All of them fall into the earliest Group I and not one of these neoplasms was fatal. The lymphosarcomas also have a fair prognosis but only because they proved to be radiosensitive, since only those patients who were irradiated survived. All the other types of tumors have an unfavorable prognosis except possibly some fibrosarcomas which tend to remain localized for considerable time and may be completely excised.

It is unnecessary to present tables showing the results from operation only and operation

with postoperative roentgenotherapy for Group I and Group II cases because it was found that there was very little difference in the results obtained by either therapeutic procedure for these more favorable groups. It was found that postoperative roentgenotherapy gave no better results in Group I cases than operation alone. This might be expected because the operation removed completely all the localized tumors in these early cases. However, in Group II it was found that a slightly higher proportion of patients survived in each yearly period if postoperative roentgenotherapy was given than if operation was the only treatment although, after the 5 year period, the proportion of known living was almost the same. The known dead of cancer in the irradiated series was proportionately somewhat less than in the non-irradiated. This would appear to indicate that postoperative roentgenotherapy was beneficial in prolonging the lives of some Group II patients.

Table VI shows that no patient with advanced disease in Group III survived even one year following operation alone, no matter what type of tumor was present. There was an exceptionally high operative mortality, over 70 per cent, as some operations were decompressions done only for palliation.

TABLE IV—ALL CASES IN GROUPS ACCORDING TO TREATMENT

Treatment	G I	G II	G III	Total	Per cent treated	Recurrent cases	Total cases	Per cent of all cases
Operations only	17	5		22	30		22	29
Operations + rx		12	21	33	47		33	43
X rx only			30	30	72		30	39
Operations + roentgen								
Radiation only			3	3				
Total treated	22	30	24	76	76		76	100
No treatment			24	24			24	31
Total cases	22	30	48	100	100	24	100	100

Table IV shows the different methods of treatment employed for the cases in each group. In Group I operation only was performed in 17 of the total 46 primary cases, or 37 per cent. Of the 46 cases in which operation was the only treatment 25 or over 50 per cent, were in the early and moderately early Groups I and II while 29, or 63 per cent, were in the less favorable Groups II and III. On the other hand, of the total 74 cases which had roentgenotherapy after operation only 12 or 14.8 per cent, were in Group I and 33 or 43 per cent in the early and moderately early Groups I and II but 63 or 85 per cent were in the less favorable Groups II and III. Therefore, roentgenotherapy was given after operation in this series in a larger proportion of advanced cases than the proportion in which operation was the only treatment. This supports the previous statement to the effect that a large proportion of cases irradiated are in advanced stages of the disease and this fact should be taken into consideration in passing judgment about the comparative efficacy of these therapeutic procedures.

In this study the patients treated by procedures other than operation and postoperative roentgenotherapy those not treated and recurrent cases are not given consideration except that they are taken into account in the totals determining the pathological classification or the groupings.

The tables dealing with the mortality statistics of the primary treated cases show

1 The operative mortality which includes all patients who died in the hospital immediately following any operative procedure whether an attempt was made to re-

move all or only a portion of the thyroid gland, or whether only palliative operations such as decompression or biopsies were done. However when only biopsies or palliative operations were done and the patient survived and irradiation followed the minor operative procedure is not considered as operation followed by irradiation but these are included in the series having roentgenotherapy only. The operative mortality cases are included among the known dead of cancer in the first year period following.

2 The number of known living is reduced in succeeding years by the total number of cases lost trace, dead not of cancer and known dead of cancer. Those known to have lived free from cancer but died not of cancer after 5 years are included in the known living after 5 years.

3 The "lost trace" are those in which the outcome was not known, and the number lost in each yearly period is added to the total of the preceding year.

4. When the death of a patient was proved to be caused by a disease other than the malignant neoplasm, it is recorded shown as dead not of cancer and the number is added to the total of the preceding year.

5 The "known dead" include all not proved to have been dead not of cancer and the number of deaths in any yearly period is added to the total of the preceding year. It should be noted that the number of lost trace and "dead not of cancer" are accounted for in each yearly period except that the cases dead not of cancer after 5 or more years of survival are taken as known living. Every primary case in the series is accounted for.

TABLE V—SUMMARY OF RESULTS IN ALL PRIMARY CASES ACCORDING TO CLASSIFICATION

Pathological classification	Total cases	Operative mortality	No of known living					
			1 yr	2 yr	3 yr	4 yr	5 yr	5+ yr
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Papillary carcinoma	22	0	19	17	15	14	13	12
Adenocarcinoma not adenoma	19	0	16	15	14	14	14	13
Sarctous carcinoma	3	2	0	0	0	0	0	0
Carcinoma sarcoma	1	0	1	0	0	0	0	0
Lymphosarcoma	11	1	3	3	3	3	3	3
Fibrosarcoma	3	0	1	1	1	1	1	1
Myxosarcoma	1	0	1	1	0	0	0	0
Unclassified	15	3	5	2	2	2	2	2
Unknown pathology	52	1	9	5	2	1	1	1
Total	200	17	92	76	64	57	53	41
Lost trace	34		20	13	27	31	33	34
Dead not of carcinoma	8		2	3	4	5	5	8
Dead of carcinoma	117	17	86	63	105	107	100	117

The results obtained in all the different types of tumors by all therapeutic procedures are shown in Table V. Although it would appear that the malignant adenomas present a fairly favorable prognosis, it should be recalled that only about one-third of them were in the early Groups I and II. However, as will be shown later (Table VI), not one of the patients with this type of tumor in the advanced stages (Group III) having operation alone, was known to be living at the end of one year. The papillary carcinomas are shown to have a considerably better prognosis since over one-half of these patients lived 5 or more years but also only 2 of 22 cases with papillary carcinomas were placed in the unfavorable advanced Group III. The tiny adenocarcinomas not in adenomas give the very best prognosis. All of them fall into the earliest Group I and not one of these neoplasms was fatal. The lymphosarcomas also have a fair prognosis but only because they proved to be radiosensitive, since only those patients who were irradiated survived. All the other types of tumors have an unfavorable prognosis except possibly some fibrosarcomas which tend to remain localized for considerable time and may be completely excised.

It is unnecessary to present tables showing the results from operation only and operation

with postoperative roentgenotherapy for Group I and Group II cases because it was found that there was very little difference in the results obtained by either therapeutic procedure for these more favorable groups. It was found that postoperative roentgenotherapy gave no better results in Group I cases than operation alone. This might be expected because the operation removed completely all the localized tumors in these early cases. However, in Group II it was found that a slightly higher proportion of patients survived in each yearly period if postoperative roentgenotherapy was given than if operation was the only treatment although, after the 5 year period, the proportion of known living was almost the same. The known dead of cancer in the irradiated series was proportionately somewhat less than in the non-irradiated. This would appear to indicate that postoperative roentgenotherapy was beneficial in prolonging the lives of some Group II patients.

Table VI shows that no patient with advanced disease in Group III survived even one year following operation alone, no matter what type of tumor was present. There was an exceptionally high operative mortality, over 70 per cent, as some operations were decompressions done only for palliation.

TABLE VI.—GROUP III. RESULTS OF OPERATION ALONE IN PRIMARY CLASSIFIED CASES

Pathological classification	Total cases	Operative mortality	No. of known living					
			3Y	5Y	10Y	15Y	20Y	25Y
Malignant adenoma		1						
Squamous carcinoma								
Lymphosarcoma								
Ovarian		2						
Unknown pathology								
Total	51							
Lost trace								
Dead not of carcinoma								
Known dead of carcinoma	20	1	20	20	20	20	20	20

TABLE VII.—GROUP III. RESULTS OF OPERATION AND POSTOPERATIVE ROENTGENOTHERAPY IN PRIMARY CASES

Pathological classification	Total cases	Operative mortality	No. of known living					
			3Y	5Y	10Y	15Y	20Y	25Y
Malignant adenoma	24		24	11	5		4	
Papillary carcinoma								
Carcinoma in situ								
Lymphosarcoma						3		
Fibrosarcoma								
Ovarian								
Total			24	11	5		10	4
Lost trace								
Dead not of carcinoma	1							
Dead of carcinoma	14		16	12	1	17	14	17

However Table VII shows that some patients in the same category Group III, with advanced disease survived as long as 5 years after treatment by roentgenotherapy following operation even though the types of tumor present have been considered as the least favorable. Six of 41 of these patients or 14.6 per cent are known to have survived more than 5 years, and 10, or 25 per cent, to the end of the fifth year. It is shown that, although the number of known dead increased year by year after the first year there was a fair proportion known to be alive in each yearly period.

These observations suggest that when a clinical diagnosis of a malignant tumor of the thyroid can be made and there is evidence that it has extended or invaded outside the thyroid capsule radical operative procedures

are not indicated because all of the neoplastic tissue cannot be removed. Instead the patient should be treated primarily by irradiation, either radium, roentgenotherapy or both according to indications.

A summary of the results obtained by different methods of treatment for different groups of cases is further illustrated by Table VIII in which it should be noted that no deductions are made for the lost trace or "dead not of cancer" up to 5 years. This tabulation also shows that 40 of 156 or 25.6 per cent of all primary treated cases, were known to be surviving after 5 years and 116 or 55.8 per cent were known dead the others, 18.6 per cent having been lost or dead not of cancer (14.1 per cent). If the 22 lost cases, and the 4 dead not of cancer prior to the 5 year period are discarded then 130 of a total

TABLE VIII—RESULTS OF TREATMENT IN ALL PRIMARY CASES

Group	Treatment	Total cases	Operative mortality	No of known living					
				1 yr	2 yr	3 yr	4 yr	5 yr	5+ yr
I	Operation only	17	0	14	12	12	12	12	12
	Operation + x ray	11	0	10	10	8	8	7	7
	Total	28	0	24	22	20	20	19	19
II	Operation only	8	1	6	6	5	4	4	4
	Operation + x ray	22	0	20	20	17	15	13	12
	Total	30	1	26	26	22	19	17	15
III	Operation only	21	15	0	0	0	0	0	0
	Operation + x ray	41	0	24	17	14	11	10	6
	\ ray only	29	0	7	5	4	4	4	2
	Operation + radium	3	0	1	1	0	0	0	0
	Radium only	4	0	1	1	1	0	0	0
	Total	98	15	33	24	19	15	14	6
All primary cases		156	16	83	72	61	54	50	40
Lost trace		22		10	13	15	20	22	22
Dead not of carcinoma		7		2	3	4	4	4	
Dead of carcinoma		87	16	61	68	76	78	80	87
Total		116	16	73	84	95	102	106	116

of 156 primary treated cases remain and on the basis of this method sometimes employed in compiling statistics 30.3 per cent of patients are known to have lived more than 5 years as a result of all methods of treatment.

The operative procedures employed with the object of curing either unsuspected or clinically diagnosable malignant tumors of the thyroid gland in this series were complete or partial thyroidectomies or lobectomies. The palliative operations were partial thyroidectomies or decompressions to remove part of the diseased gland or tracheotomies primarily for the relief of respiratory distress or biopsies.

The roentgenotherapy was administered according to the method employed 5 or more years ago. The right and left thyroid areas, the posterior cervical, and the anterior and posterior mediastinum were usually irradiated, the trachea and larynx being protected. Each field received one skin tolerance dose of 800 r's in one or 2 treatments using 200 kilovolts and 0.75 millimeters of copper with 1 millimeter of aluminum for filter (h.v.l. 1.0 millimeter copper) at 50 millimeters distance. Thus the entire course of treatment

was given within 5 to 10 days. Approximately half the patients received only one course of treatment because of the fear of severe skin reactions, others were given 2 courses and a few received 3 or more courses at widely spaced intervals of many months according to indications.

Radiologists will appreciate that this method was inadequate as compared with more recently developed and more efficacious procedures. The antiquated method employed for administering roentgenotherapy in this series of cases has been discarded. At present the same physical and mechanical factors are being employed but the same anatomical fields are each given from 200 to 250 r's on alternating days so that the entire course of treatment is prolonged to 3 or more weeks and the total dosage is about 3 or more times as great as previously. The immediate results noted by the newer method appear far superior.

CONCLUSIONS

1. The incidence of histological types of malignant tumors of the thyroid gland is shown in a series of 200 consecutive cases of which 74 per cent were classifiable.

2 The prognosis for each histological type by different methods of treatment has been shown and a comparison made between operation alone and operation followed by roentgenotherapy.

3 A plan is suggested for the grouping of cases according to the extent of disease regardless of histological types for statistical studies or comparisons of the results of different methods of treatment.

4. According to the grouping plan suggested, about 15 per cent of cases fall into Group I and present no clinical manifestations. They are discovered only by the pathologist and are curable by operation alone. Irradiation by any method is of no benefit.

5 Approximately 16 per cent of cases fall into an intermediate Group II without evidence of extension outside the thyroid capsule. Of this group about 50 per cent are curable by operation alone, and postoperative roentgenotherapy seems to have been of benefit because the lives of some patients were prolonged.

6. About two-thirds of all patients are in advanced stages of disease and fall into Group III the presence of the malignant tumor being manifest clinically. Of these, none survived one year by operation alone, but a few survived as long as 5 years following postoperative roentgenotherapy.

7 The statistical study indicates that only palliative operations are indicated for advanced and clinically diagnosable malignant tumors of the thyroid gland and that irradiation by roentgenotherapy alone or in combination with radium treatment according to individual indications should be the only therapeutic procedures for a large proportion of this group.

8. The advances made in irradiation procedures since this series of cases was treated indicate that even better results may be anticipated in the future.

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- GRAHAM, ALLEN. Malignant tumors of the thyroid, epithelial types. *Ann. Surg.* 92:5, 27-30-31

CLINICAL SURGERY

FROM THE AMSTERDAM EYE CLINIC

PLASTIC RESTORATION OF A DEFORMITY CAUSED BY COMPLETE EXENTERATION OF THE ORBIT

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EXENTERATION of the orbit for a tumor is followed by a deformity which may be corrected by a plastic operation. The method used in a recent case involved a four-stage operation wherein by means of free and pedunculated fat transplants the orbit was prepared for an Esser-Wheeler operation.

The exenteration had been complete and only the skin of the eyelids was preserved and served as a partial covering of the walls of the orbit. Granulation tissue lined the apex of the orbit when the patient was first observed, but finally became covered by epithelium (Fig 1).

An incision is made parallel with and a few millimeters beneath the inferior margin of the orbit at the first operation (Fig 2). The skin over the inferior orbital margin is dissected free and a large pocket made by separating the skin and a thin layer of subcutaneous tissue in the infra-orbital region from the underlying tissue. This pocket is filled with a free transplant of fat and connective tissue which is obtained from the radial side of the thigh over the fascia lata. The sutures

have been introduced previously so that the wound can be closed accurately and immediately after the implantation of the fat. Fat from the region of the fascia lata is selected because it contains more connective tissue than the fat from the buttocks or the abdominal wall. The quality of the transplanted fat and the ideal nutrition of the transplant produce very little shrinkage.

Figure 3 shows the first step of the second operation. The scar of the first operation is circumscribed and the epithelial edges are removed. The skin is dissected downward, medially and laterally, and upward across the floor of the orbit to the horizontal ridge at the apex of the orbit. The skin of the upper eyelid is separated from the orbital wall over a short distance. The edge of the transplanted fat should then be pulled toward the ridge in the apex of the orbit and fixed there with 4 catgut sutures so that the floor of the orbit becomes covered by thick pedunculated fat and connective tissue (Figs 4 and 5). Figure 6 shows the result that is obtained following the second stage of the procedure.



Fig 1



Fig 2



Fig 3

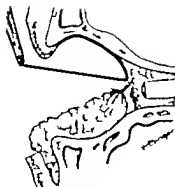


Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8

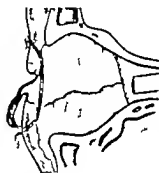


Fig. 9



Fig. 10



Fig.



Fig.

INTRACRANIAL COLLECTIONS OF IODIZED OIL FOLLOWING LUMBAR MYELOGRAPHY

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ONE of the most valuable applications of contrast media in the diagnosis and localization of certain lesions of the spinal cord is the use of iodized oil in the subarachnoid space. This space was first visualized pre-operatively with air by Dandy in 1919, but, following the introduction of lipiodol by Sicard and Forestier in 1921, air was soon replaced by the use of small amounts of opaque oil. Air is of such low contrast in comparison with lipiodol that one can understand Dandy's remark, the poorest radiograph made with lipiodol is superior to the best one made with air. This was quite true, when one makes allowance for the contrast obtainable in roentgenograms at that time; however, with modern roentgenographic technique Chamberlain and others have shown that air may be a very useful contrast medium especially in thin subjects. On the whole, however, most physicians regard the use of opaque oil as superior to that of air and, of the opaque oils, lipiodol is perhaps the one most used at the present time.

It has been known for many years that the opaque oil remains indefinitely unless removed at operation, which is a very difficult and seldom accomplished feat, and that it may be scattered throughout the entire cerebrospinal fluid pathway. Most clinicians are of the impression that it is somewhat irritating and that it is apt to become encapsulated in or about the lower portion of the spinal sac. Some time ago it was our privilege (E. J. M.) to see in consultation a patient who had rather bizarre cerebral symptoms. Roentgenographic examination of this patient's skull revealed large amounts of opaque oil in the ventricular and subarachnoid spaces (Fig. 1) residual from lumbar myelography performed 3 years previously, and the question arose as to whether or not the cerebral symptoms were due to the intracranial oil (Case 1). A survey of the literature revealed no specific information on clinical symptoms or pathological changes due to prolonged retention of lipiodol intracranially,

although there was considerable material on late changes in and about the meninges of the cord. In order to study this problem under clinical conditions, it was decided to have return for examination a group of patients, who had had lipiodol injected into their spinal canals several years previously. The present paper is a résumé of the clinical and roentgenological findings in these patients, a report of the autopsy findings in one case, and a review of the literature.

CLINICAL AND PATHOLOGICAL REACTIONS REPORTED IN THE LITERATURE

There are numerous reports of local reactions both early and late following the injection of opaque oil in the spinal subarachnoid system but only scant literature dealing with reactions in and about the cerebrum. This is rather surprising, since even in their earliest publications, Sicard and Forestier reported the presence of the oil in the cranium following maintenance of the patient in Trendelenburg position for some minutes.

Intraspinal (subarachnoid) lipiodol. Sicard and Forestier both in their early publications in 1921 and later monograph in 1923 reported that immediately after the subarachnoid injection of lipiodol there was an increase in the white cell count of the spinal fluid lasting for about 4 days; that in patients whose spinal subarachnoid space was normal, there were sometimes symptoms such as mild headache and cramps in the lower limbs, and a rise in temperature of about 1 degree Fahrenheit. This reaction lasted for 1 or 2 days, and usually subsided without leaving any residual symptoms. In patients whose meninges were inflamed or congested as a result of recent trauma, contact of the oil with the diseased area sometimes caused a transient but quite endurable pain. In paraplegics there was sometimes an increase of spasticity and slight inhibition of the sphincters. In tabetics, there were short crises of shooting pains, tingling of the lower limbs, and occasionally transitory disturbances of the sphincters. Patients afflicted with general paresis did not show any reactions at all. In all of their cases reactions of this kind disappeared completely within 4 days. They believed that a simple lum-

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bar puncture was capable of producing similar effects in certain cases. They did not observe any late reactions although they reported that the lipiodol disappeared very slowly.

Aver and Mixer in 1924 performed some experimental work on cats and found very high spinal fluid cell counts following cisternal injection of 40 per cent iodized sesame oil. However, in proportion to the dosage used in humans their animal dose was approximately 5 times as great. Mchurc in 1925 and Sharpe and Peterson in 1926 reported what they believed was a case of severe meningeal inflammation following the use of lipiodol. The patient had sustained a fractured fourth thoracic vertebra, a few years later signs of spinal cord compression and irritation developed. Subarachnoid lipiodol injection revealed a block at the level of the seventh thoracic vertebra. Laminectomy was performed at the level of the fourth thoracic vertebra, nothing abnormal was found, the incision was closed. The patient grew worse and 5 months later laminectomy was performed at the level of the tenth thoracic vertebra, the lipiodol was found encysted in adhesions and there was considerable local arachnoiditis. Mchurc and Sharpe believed that the lipiodol alone brought on the meningeal inflammation. Sicard, discussing this case, believed that the adhesions and arachnoiditis antedated the injection of the oil, but again emphasized the occasional disturbances produced by lipiodol in cases of old spinal traumatism. Laugh and Mella in 1926 reported a transient aseptic meningitis following intracisternal injection of iodized oil in 13 cases. Wolfsohn and Morrissey in 1927 reported inflammatory changes around tumors in 2 cases follow ing lipiodol injection.

Globus and Strauss in 1929 reported the results of subarachnoid injection of lipiodol in 64 cases. They concluded that in only one out of this group was there any clinical evidence of meningeal irritation, in this patient there was transient vasomotor disturbance and pain in segments approximating the level of the oil and tumor. They noted that 25 patients who had had iodized oil in their spinal canals for more than 2 years were normal upon examination, both roentgenologically and neurologically. Although the oil showed little diminution in bulk "it remained freely movable within the subarachnoid space and showed no evidence of any adhesive process." In one instance a necropsy was performed 3½ months after injection, there was no evidence of any inflammatory process of the meninges at the site at which the iodized oil had been arrested. They believe that the iodized oil was absorbed

extremely slowly but that it remained freely movable. Elberg, in discussing this paper, stated "I thoroughly believe that iodized oil is an irritant. I have seen in a number of instances fresh adhesions and marked congestion of the meninges changes which are not ordinarily observed when the spinal cord is exposed during laminectomy. I have always explained this as the result of the irritative qualities of this foreign substance."

Davis, Haven and Stone in 1930 reported the results of intracisternal injection of lipiodol in 10 dogs. In 8 of them they found a severe leptomeningeal reaction and concluded that the injection of iodized oil into the subarachnoid space was a dangerous procedure. They did not report the findings in control dogs, all animals having had artificially produced subarachnoid blocks.

Emblom performed a critical investigation in 1931 of the effects of various iodized oils on the meninges. He found that the degree of irritation caused by the oil varied with the amount of free fatty acid, sesame oil acidity 0.6 produced no irritation, refined poppy seed oil acidity 2.4, produced moderate irritation, while ordinary poppy seed oil, acidity 6.5 produced marked irritation. He found that the iodized product of the oil caused greater irritation than the oil itself, the free fatty acid being transformed into iodic fatty acid. He regarded lipiodol as an impure iodized oil but found that its impurities were absorbed comparatively easily, while the iodized oil itself was absorbed slowly. He noted in rabbits that after the injection of oils that were absorbed slowly, a sort of "pseudo tumor" or fatty granuloma was sometimes found in the subarachnoid cavity. These did not always develop and when they did develop took at least 6 months. Two rabbits were given injections of 1 cubic centimeter each of lipiodol and were killed after 6 months. Before the brains were extracted the skulls were roentgenographed. In one the oil was found to have collected in large lakes, while in the other it was distributed in numerous small droplets. When the brain was removed from the former it was found to contain 2 large lakes of oil surrounded and infiltrated with new-grown connective tissue. At a third place there was a prelymphatic reaction which on incision also showed droplets of oil. Histological examination showed that these formations consisted of fatty phagocytes of various sizes, surrounded or infiltrated with new grown connective tissue (fatty granulomas). In the other specimen, in which the oil was separated into small droplets, there were no

INTRACRANIAL COLLECTIONS OF IODIZED OIL FOLLOWING LUMBAR MYELOGRAPHY

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ONE of the most valuable applications of contrast media in the diagnosis and localization of certain lesions of the spinal cord is the use of iodized oil in the subarachnoid space. This space was first visualized pre-operatively with air by Dandy in 1919 but, following the introduction of lipiodol by Sicard and Forestier in 1922 air was soon replaced by the use of small amounts of opaque oil. Air is of such low contrast in comparison with lipiodol that one can understand Dandy's remark, "the poorest radiograph made with lipiodol is superior to the best one made with air." This was quite true when one makes allowance for the contrast obtainable in roentgenograms at that time however with modern roentgenographic technique Chamberlain and others have shown that air may be a very useful contrast medium especially in thin subjects. On the whole however most physicians regard the use of opaque oil as superior to that of air and of the opaque oils, lipiodol is perhaps the one most used at the present time.

It has been known for many years that the opaque oil remains indefinitely unless removed at operation, which is a very difficult and seldom accomplished feat, and that it may be scattered throughout the entire cerebrospinal fluid pathway. Most clinicians are of the impression that it is somewhat irritating and that it is apt to become encapsulated in or about the lower portion of the spinal sac. Some time ago it was our privilege (E. J. M.) to see in consultation a patient who had rather bizarre cerebral symptoms. Roentgenographic examination of this patient's skull revealed large amounts of opaque oil in the ventricular and subarachnoid spaces (Fig. 1) residual from lumbar myelography performed 3 years previously and the question arose as to whether or not the cerebral symptoms were due to the intracranial oil (Case 1). A survey of the literature revealed no specific information on clinical symptoms or pathological changes due to prolonged retention of lipiodol intracranially

although there was considerable material on late changes in and about the meninges of the cord. In order to study this problem under clinical conditions, it was decided to have return for examination a group of patients, who had had lipiodol injected into their spinal canals several years previously. The present paper is a résumé of the clinical and roentgenological findings in these patients, a report of the autopsy findings in one case and a review of the literature.

CLINICAL AND PATHOLOGICAL REACTIONS REPORTED IN THE LITERATURE

There are numerous reports of local reactions both early and late following the injection of opaque oil in the spinal subarachnoid system, but only scant literature dealing with reactions in and about the cerebrum. This is rather surprising since even in their earliest publications, Sicard and Forestier reported the presence of the oil in the cranium following maintenance of the patient in Trendelenburg position for some minutes.

Intraspinal (subarachnoid) lipiodol. Sicard and Forestier both in their early publications in 1922 and later monograph in 1933 reported that immediately after the subarachnoid injection of lipiodol there was an increase in the white cell count of the spinal fluid lasting for about 4 days; that in patients whose spinal subarachnoid space was normal, there were sometimes symptoms such as mild headache and cramps in the lower limbs, and a rise in temperature of about 2 degrees Fahrenheit. This reaction lasted for 2 or 3 days, and usually subsided without leaving any residual symptoms. In patients whose meninges were inflamed or congested as a result of recent trauma, contact of the oil with the diseased area sometimes caused a transient but quite endurable pain. In paraplegics there was sometimes an increase of spasticity and slight inhibition of the sphincters. In tabetics, there were short crises of shooting pains, tingling of the lower limbs, and occasionally transitory disturbances of the sphincters. Patients afflicted with general paresis did not show any reactions at all. In all of their cases reactions of this kind disappeared completely within 4 days. They believed that a simple lum-

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bar puncture was capable of producing similar effects in certain cases. They did not observe any late reactions, although they reported that the lipiodol disappeared very slowly.

Ayer and Mixer in 1924 performed some experimental work on cats and found very high spinal fluid cell counts following cisternal injection of 40 per cent iodized sesame oil. However, in proportion to the dosage used in humans their animal dose was approximately 5 times as great. MacLure in 1925 and Sharpe and Peterson in 1926 reported what they believed was a case of severe meningeal inflammation following the use of lipiodol. The patient had sustained a fractured fourth thoracic vertebra, a few years later signs of spinal cord compression and irritation developed. Subarachnoid lipiodol injection revealed a block at the level of the seventh thoracic vertebra. Laminectomy was performed at the level of the fourth thoracic vertebra; nothing abnormal was found; the incision was closed. The patient grew worse and 5 months later laminectomy was performed at the level of the tenth thoracic vertebra; the lipiodol was found encysted in adhesions and there was considerable local arachnoiditis. MacLure and Sharpe believed that the lipiodol alone brought on the meningeal inflammation. Sicard, discussing this case, believed that the adhesions and arachnoiditis antedated the injection of the oil, but again emphasized the occasional disturbances produced by lipiodol in cases of old spinal traumatism. Lbaugh and Mella in 1926 reported a transient aseptic meningitis following intracisternal injection of iodized oil in 13 cases. Wolfsohn and Morrissey in 1927 reported inflammatory changes around tumors in 2 cases following lipiodol injection.

Globus and Strauss in 1929 reported the results of subarachnoid injection of lipiodol in 64 cases. They concluded that in only one out of this group was there any clinical evidence of meningeal irritation, in this patient there was transient vasomotor disturbance and pain in segments approximating the level of the oil and tumor. They noted that 25 patients who had had iodized oil in their spinal canals for more than 2 years were normal upon examination, both roentgenologically and neurologically. Although the oil showed little diminution in bulk "it remained freely movable within the subarachnoid space and showed no evidence of any adhesive process." In one instance a necropsy was performed 3½ months after injection, there was no evidence of any inflammatory process of the meninges at the site at which the iodized oil had been arrested. They believe that the iodized oil was absorbed

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granulomas numerous small droplets were found in the arachnoid membrane itself but without reaction. Lindbloom observed the literature contains a few cases of dissection on humans after lipiodol injection judging from the histologic descriptions it seems likely that fatty granulomata were present in some of them. These granulomata appear to develop when the oil gathers in large lakes. Further investigation is required to confirm this point and also to determine whether or not these granulomata have any clinical significance.

Brustlin and Propper reported the results of experimental myelo-encephalography in dogs in 1931. They injected iodipin subdurally and found no disturbances of sensation or motor function. Pathological examination after from 3 to 3 months revealed granulation tissue formations over the spinal cord. In some areas there was destruction of the gray substance of the cord itself however it should be noted that the oil was injected into the cord itself in dogs. These authors believe that the iodine and oil split up, the former producing the reaction.

Fumarola and Enderle reported one alleged fatality in 1932 following the cisternal injection of lipiodol, but gave no histological details. Hampton and Robinson in 1936 reported the absence of any serious or permanent reaction following the use of 3 cubic centimeters of lipiodol in over 100 examinations, and 5 cubic centimeters in 75 examinations. They observed that the oil often produces a definite reaction, lasting for several days, characterized by elevation of the spinal fluid cell count, changes in the color and chemical composition of the fluid, headaches, increase in the pain of which the patient complained, and slight fever. They comment that those that use the oil most frequently find the fewest reactions. They state that the oil did not become encysted even after years. However, they do not recommend the indiscriminate use of the oil and examine the upper thoracic spine only when symptoms referable to that portion of the canal are present which may account for the infrequency of some of the toward reactions which others attribute to the use of lipiodol.

In an article (entitled "and cisternal") lipiodol Sicard and Forestier in 1926 suggested the use of ordinary lipiodol for outlining the cerebral ventricles and published illustrations of a few cases however 6 years later they advised against it owing to early reactions in the form of severe headache and pyrexia. They observed no toward late effects, however. Sicard and others

reported the use of "ascending lipiodol" and of ascending lipiodol emulsified with spinal fluid in ventriculography. They found the latter mixture to be exceedingly irritating because of the extremely small state of division of the oil droplets, which are more easily attacked by the white cells and minute quantities of iodine liberated. They found that in tuberculous meningitis the reaction was intense, being accompanied by nausea, vomiting and even exultus, and advised against the use of either ordinary or light oil for such purposes.

Brandt, in 1933 reported the case of a patient with tuberculous spondylitis in whom 2 cubic centimeters of iodipin had been injected into the lumbar subarachnoid space 5½ months prior to autopsy. At autopsy numerous bright yellow nodules, varying from 2 to 4 millimeters in diameter and resembling grapes in shape were seen about the base of the brain, being especially numerous in the region of the basal cisternae. These appeared to lie between the pia mater and the brain. They were easily movable and burst on slight pressure. Chemical examination showed that these nodules contained iodine. Microscopic examination showed only a structureless meningeal pathology. No pathological changes attributable to the iodine could be found in the neighboring brain.

Ouchi in 1935, discussed 5 cases in which he had used opaque oil for myelography. In several of these cases he reported mild early reactions such as nausea, irritability, pyrexia, and so forth, all of which disappeared within a week. In one instance he erroneously injected the oil in a case of tuberculous meningitis shortly thereafter the patient died. Ouchi attributed the patient's death to the meningitis and not the lipiodol. However he believed that it may oil have aggravated the patient's disease. In 7 cases he believed the oil exercised a therapeutically beneficial influence. In no cases did he meet with late harmful effects and did not think the oil showed any tendency to become encapsulated or form granulomas "as described in the literature."

Schuller in 1936, investigated patients with possible tumors at the base of the brain by suboccipital or intraspinal injection of 40 per cent iodipin. He recommended this contrast filling of the basal cisternae because (1) the material is stable and there were no immediate or late unfavorable reactions, (2) the material was easily visible under the fluoroscopic screen, and (3) following investigation of the basal cisternae the opaque oil could be displaced into the spinal subarachnoid space and thereby retained for further

By ordinary lipiodol means sicard and propper used oil, 50 per cent iodine
 ordinary lipiodol special light oil and contains only 10 per cent iodine

later investigations of the cisternæ. His article contains 9 illustrations showing oil in the skull, mostly in the form of lakes.

Carillo, in 1936, discussed the use of lipiodol for examination of the ventricular cavities. Details as to its complications are lacking.

Lvsholm, in 1938, discussed his experience with ventriculography, using both air and opaque oils, based on a total material of 3408 cases during 10 years. Of these cases 123 were lipiodol examinations, concerning which he comments that undesirable reactions sometimes occurred and that air is preferable and much less harmful.

SUMMARY OF REACTIONS REPORTED IN THE LITERATURE

Reactions to the subarachnoid injection of iodized oil may be summarized as follows:

Spinal canal. A. Immediate reactions. Pathologically there is elevation of the spinal fluid cell count and slight hyperemia about the site of injection. Clinically there may be slight headache, increase in the pain of which the patient is complaining, slight fever, and sometimes pain about the sacrum and coccyx. These pathological and clinical changes last about 2 to 5 days and then subside.

B. Late reactions. In patients without infectious or traumatic lesions involving the spinal cord or meninges there are usually no late clinical reactions. Coccygeal pain, if present, usually subsides within 3 months. The oil may lie in small droplets and lakes scattered up and down the spinal canal, sometimes extending out along the nerve sheaths. Many of the smaller droplets may be movable. Occasionally the oil becomes encapsulated in the cul de sac at the base of the spinal canal. For as long as 3 years following injection the larger collections may show considerable motion, and may even be used for refilling various portions of the spinal canal for investigation. After about 3 years they tend to become encapsulated in various areas. Fibroblastic proliferation and pseudogranulomas may develop about the oil.

Cranial cavity. There have been only a few references to immediate or late reactions in the cranial cavity. Those authors who deliberately used the oil to explore the basal cisternæ reported minimal reactions of a transitory nature, while those who used it to explore the ventricles reported more unpleasant reactions, leading as a rule to the discarding of the method. Many

authors have referred to possible late clinical reactions from the presence of lipiodol or other opaque oil in the cranial cavity, but none have reported specific examples. It is to clear up any doubts on the latter that this paper is being presented.

In concluding our remarks on the literature dealing with reactions to the subarachnoid injection of lipiodol, it is to be remembered that mild reactions also follow the injection of air. Of course, no granulomas have been found following simple spinal puncture or air injection, but most of the clinical reactions above noted have been reported following the injection of air. As Lindholm observes, "further investigation should be made to determine whether or not the lipiodol granulomata have any clinical significance."

Most neurosurgeons and clinicians, discussing the use of subarachnoid lipiodol in the diagnosis of spinal cord lesions, emphasize that the oil should be aspirated at the time of laminectomy. Indeed, most surgeons routinely report that "oil was removed at operation." Roentgenological investigation has convinced us that it is rare that more than one third of the oil has been removed. Lucherini, in 1936, described a method of removing the oil by making a burr opening in the sacral crest at the level of the second sacral body, puncturing the dura and arachnoid, and aspirating the oil. Nosik and Mortensen in an effort to obviate the "unpleasant symptoms of root irritation produced by lipiodol" recently used thorotrast in experimental animals. Following its use they lavaged the cerebrospinal system in order to remove it. This appears to us to be an unnecessarily complicated procedure. Mettler and Leake stress the importance of removing all traces of oil at operation, without apparently realizing how difficult a task this is. Indeed, we suspect that undue efforts at removal would be more harmful than leaving the oil *in situ*.

REPORTS OF CASES RETAINING OIL INTRACRANIALY

Having had our attention drawn to the presence of lipiodol in the cranial cavity by the case mentioned in the opening paragraph of this paper, we reviewed with the invaluable assistance of Dr. Earl Miller those cases in our files in which we could get patients to return for examination, excluding the spinal cord tumor cases, which are being reported separately. All the patients recalled had received subarachnoid lipiodol injections from 1 to 13 years previously, 3 to 5 cubic centimeters of oil having been used in most instances. In 9 of these patients no lipiodol was found in the skull at the time of roentgenographic examination. In

¹We are assuming that the oil used is a non irritating purified vegetable oil of low acidity, and containing from 30 to 60 per cent iodine or similar halogen, that it is in absolutely fresh condition, and is used in amounts of not over 5 cubic centimeters.



Fig. 1



Fig. 2



Fig. 3

Fig. Case. Intracranial iodized oil for years. The patient had 4 cubic centimeters of lipiodol injected into the lumbar subarachnoid space in January, 1937. At the present time large globules of lipiodol are scattered throughout the subarachnoid spaces over the right parietal region, some in the base of the anterior saddle and posterior fossa, and some in the third and lateral ventricles. These globules show negligible change in position with changes in posture and are apparently fixed, as encysted in various portions of the pia and arachnoid. No clinical symptoms attributable to the oil. *b*, Lateral projection. *c*, Occipital projection. See Figure 1.

patients immediately and also 1 week after lumbar subarachnoid injection of lipiodol, placing them in extreme Trendelenburg position, and filling their intracranial subarachnoid spaces. In neither of these patients were any symptoms noted which could be attributed to the lipiodol in and about the brain.

Of the 6 patients who had lipiodol in and about the brain for from 1 to 13 years, several had no neurological complaints. Careful review of all of these patients' histories revealed that identical complaints existed before the date of first lumbar puncture and injection of lipiodol. In no case was there any new symptom which could be attributed to the presence of the oil in the brain or meninges.

In order to emphasize this point we are recording the neurological symptoms and findings before the injection of lipiodol, and those noted after x-ray examination revealed the opaque oil in and about the brain in the 9 most instructive cases. The other cases have been summarized. We are also reproducing the roentgenograms of several of these cases, and the histological appearances

6 patients oil was found, large amounts in 7 and small amounts in the 9 remaining. In order to confirm other observers' reports on the lack of immediate symptoms following introduction of lipiodol into the cranial cavity we examined 2

of the cerebral meninges in one case in which we secured an autopsy

CASE 1 J V C, 53 year old engineer, complained of severe pain in the lumbar region occasionally radiating down the posterior surface of the left thigh and leg. No evidence of subarachnoid block was noted following lipiodol injection. Lumbosacral fusion was performed. Five months later he developed cerebral symptoms. Roentgenograms of the skull showed lipiodol scattered throughout the subarachnoid space and ventricles (Fig 1).

The patient was first seen on December 8, 1936, being referred by Dr J M Mehern. The family and past history was essentially negative except that he was kicked over the left frontal region by a cow at the age of 11. The patient was not unconscious and has had no cerebral symptoms attributable to the injury. The patient denied any previous back injuries. On July 14, 1936, as he was walking backward, pulling a car load of cord wood down a ramp, his foot slipped, and he slid off into a pit. He immediately noted pain in the lower back which radiated down the back of his left thigh and leg to his toes. He climbed out of the pit and lay down for about 15 minutes, following which he went home. Next morning he was unable to get out of bed because of the severe lower back pain. On July 29, 1936, he had severe spasms of pain in the left thigh and leg and was taken to the hospital by ambulance. The spasm lasted for about 1 week and was somewhat improved by hot compresses. About 1 week after the accident he first noticed numbness along the lateral side of the left thigh and leg, and the foot felt colder than the other. He was discharged from the hospital after 6 weeks, remained in bed at home for 1 week, and was then allowed up and about. His condition did not improve.

Examination on December 1, 1936, showed the patient to be well developed and nourished. Temperature, pulse, and respiration were normal, blood pressure 108/70. The general physical examination was essentially negative except for spasticity of the lumbar muscles on both sides, flattening of the lumbar curve, tenderness to pressure over the third, fourth, and fifth spinous processes, especially the latter, and pain referred to the lumbosacral region on any movement involving the lumbar spine. Neurological examination. Head. Size and shape were normal. There was a healed horse shoe shaped laceration over the left frontal region. There were no areas of depression, no tenderness, and no changes on percussion. Cranial nerves. Sense of smell was normal. Visual acuity was fair, perimetric fields were normal. Ophthalmoscopic examination showed the discs to be of normal color, cupping present, margins fairly well defined, veins rather full and slightly engorged, arteries normal, and no hemorrhages or exudate. The pupils were round, equal, and reacted to light and accommodation. All external ocular muscle movements were normal. There were no sensory changes over face, muscles of mastication were normal, no facial weakness or asymmetry were present. Hearing was good in both ears. No nystagmus, past pointing, or ataxia were present. Gag and palate reflexes were normal. There was no weakness of the trapezius or sternocleidomastoid muscles, the tongue protruded in the midline with no atrophy. Lobes of brain. Patient was oriented as to time, place, and person. There was no aphasia, no definite muscle weakness, no sensory changes, no involvement of the perimetric fields, and no stereognostic disturbances. There was no past pointing, nystagmus, nor ataxia, and the Romberg was negative. Reflexes. Upper reflexes were present and equal, abdominal reflexes were present, equal, and slightly hyperactive, patellar and Achilles, present and equal. There were no pathological reflexes or clonus. Sensory. There was pos-

sibly some hypesthesia to touch and pain over the lateral surface of the left thigh but no definite area could be outlined. Roentgenograms of the lumbar spine showed a marked narrowing of the lumbosacral joint and moderate narrowing of the fourth disc. The sacral articular processes impinged on the pedicles of the fifth lumbar vertebra. There was considerable sclerosis of the lumbosacral facets. A spinal puncture was done and the fluid found to be clear, colorless, pressure not increased, Queckenstedt negative, no increase in cell count or total protein, and Wassermann reaction negative.

Because of the root pain brought on by coughing, straining, etc., and the slight weakness over the lateral surface of the left thigh and leg, lipiodol injection was done, but no block was noted. On January 26, 1937, a lumbo-sacral fusion was performed. The postoperative course was uneventful and he returned to light work in October, 1937. The patient was referred to us again (E J M) in April, 1938, and at that time he stated that for the past year, beginning while he was still wearing a body cast, he had had attacks during which he would become dazed and fall to the floor. He would get up immediately and feel normal. He did not bite his tongue, froth at the mouth, or have convulsive movements and there was no disturbance of sphincters. In September these attacks occurred as frequently as 5 or 6 times a day. In October, 1937, while driving a car he became unconscious, recovering later, at which time he was lying down on the front seat with the switch turned on and the car in the middle of a field. When he got out he was confused and had to walk along the road for some distance until he met a friend who directed him to his home. On another occasion he went under a building to clean out some steam traps and then remembers nothing until 6 hours later when he was found by scavengers. He is still complaining of pain over the lumbosacral region brought on by lifting or working in a stooped position. The pain no longer radiates down either leg and is not associated with muscle weakness or numbness. It is rather significant that the patient did not report any of these fainting attacks on his visits to the surgeon who performed the fusion. Examination in April, 1938, showed the patient to be well nourished and developed. Pulse, respiration, and blood pressure normal. The general physical examination was essentially negative, the operative incision in the lumbar region being well healed and not tender to pressure. There was some slight limitation of flexion, otherwise the spinal movements were normal.

Neurological examination in April, 1938. Head negative. Cranial nerves negative. Reflexes present and equal. No pathological reflexes or clonus. Sensory. No sensory changes to touch and pain. Motor. No muscle weakness or paralysis.

Roentgen examination of the skull in April, 1938, revealed no injury to the calvarium. There was some calcification of the dura behind the dorsum sellæ. There were numerous globules of lipiodol scattered throughout the subarachnoid spaces over the right cerebral hemisphere, some over the cerebellar hemispheres, some around the anterior and middle fossæ and, apparently, in the third and lateral ventricles. These globules appear to be fixed. There are a few globules scattered throughout the cervical portion of the spinal canal.

Although the neurological examination is negative for any positive neurological findings or evidence of increased intracranial pressure, the cerebral symptoms are somewhat suggestive of epileptic seizures and, therefore, one must consider several possibilities such as tumor, abscess,



Fig. a



Fig. b

Fig. a. Case 1. Intracranial lipiodol for 1 year. This patient had 4 cubic centimeters of lipiodol injected into the lumbar subarachnoid space in January, 1937. At the present time large globules of lipiodol are scattered throughout the subarachnoid spaces over the right parietal region, some in the base of the anterior, middle and posterior horns, and some in the third and lateral ventricles. These globules show negligible change in position with changes in posture and are apparently fixed, or encysted in various portions of the pia and arachnoid. No clinical symptoms attributable to the oil. b, Lateral projection; c, Occipital projection. See Figure



Fig. c

patients immediately and also 1 week after lumbar subarachnoid injection of lipiodol, placing them in extreme Trendelenburg position, and filling their intracranial subarachnoid spaces. In neither of these patients were any symptoms noted which could be attributed to the lipiodol in and about the brain.

Of the 6 patients who had lipiodol in and about the brain for from 1 to 13 years, several had vague neurological complaints. Careful review of all of these patients' histories revealed that identical complaints existed before the date of first lumbar puncture and injection of lipiodol. In no case was there any new symptom which could be attributed to the presence of the oil in the brain or meninges.

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16 patients oil was found, large amounts in 7 and small amounts in the 9 remaining. In order to confirm their observers' reports on the lack of immediate symptoms following introduction of lipiodol into the cranial cavity we examined 3

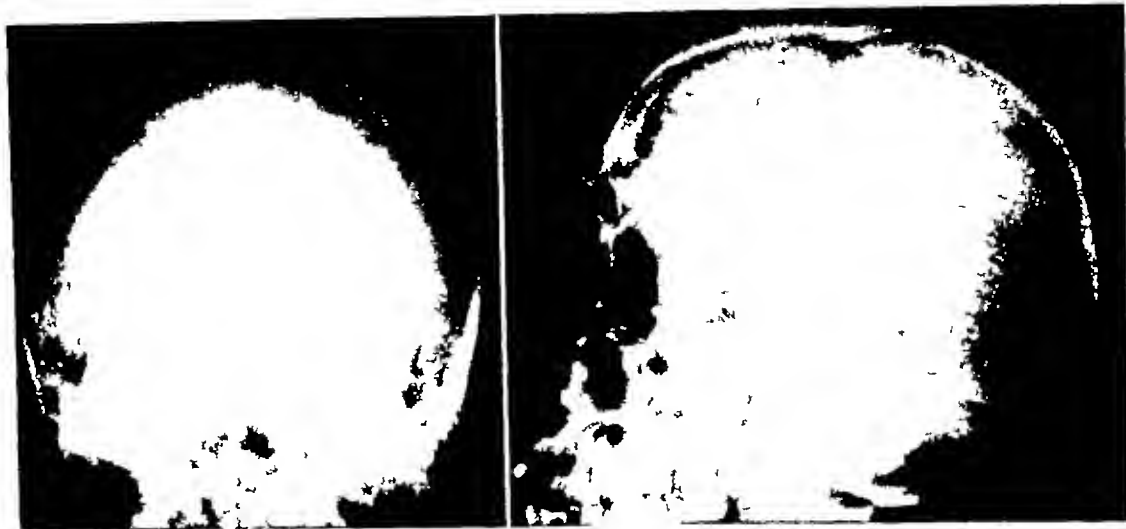


Fig 3 a, left Case 3 Intracranial iodized oil for 4 years. This patient had 4.5 cubic centimeters of lipiodol injected into the lumbar subarachnoid space in January, 1935. At operation (lumbar laminectomy) "all of the lipiodol was washed from the spinal canal and the wound closed." At

the present time there are numerous globules between the cerebral lobes, postero inferiorly, and one in the cisterna pontis. Oil apparently fixed. No symptoms or neurological findings attributable to iodized oil. b, Lateral projection.

had no symptoms or neurological findings which could be attributed to the presence of the oil. All of her multifarious subjective symptoms were present and noted in her history before the injection of the oil in October, 1934.

CASE 3. A. J., a 40 year old longshoreman, showed intracranial iodized oil 4 years after lumbar subarachnoid injection of 4.5 cubic centimeters.

In December, 1934, this patient slipped and fell while at work. He was admitted to the hospital complaining of severe pain in the lower back, extending down the posterior surface of the right leg. There was slight atrophy of the muscles of the right leg. The patient stated that this had been present since an operation just above the right knee at the age of 9. Neurological examination. The cranial nerves appeared normal. There was slight atrophy of the right side, no sensory disturbances could be detected. The right knee jerk was more active than the left, the right ankle jerk was weak. The remaining reflexes were normal. On January 15, 1935, 4.5 cubic centimeters of lipiodol was injected by lumbar puncture and a filling defect was noted on the left side of the fourth lumbar disc. At operation in February, 1935, thickening of the arachnoid was noted on the left side of this disc, but there was no evidence of tumor or retropulsion. "All of the lipiodol was washed from the spinal canal and the wound closed." Microscopic examination of the tissue removed was reported as chronic arachnoiditis. No definite cause for the sciatica was found. The patient improved for a while, but after some months the symptoms recurred and, when admitted to the San Francisco Hospital, he was again complaining of pain in the back and down the right leg.

Röntgen examination of the skull in 1938 revealed numerous globules of oil lying between the cerebral lobes,

postero inferiorly, and one in the cisterna pontis. The oil appeared fixed.

Neurological examination in 1938 revealed that the cranial nerves appeared normal. There was slight atrophy of the right thigh and calf. The right knee jerk was more active than the left, the right ankle jerk could not be elicited. The other reflexes were normal. No defect of any sensory field was detectable. The Romberg was negative. There was tenderness over the course of the sciatic nerve on the right side in the mid thigh level. Clinically the patient had no new symptoms of intracranial origin.

This patient had large amounts of iodized oil scattered throughout the cranium 4 years following lumbar myelography. No symptoms or neurological findings attributable to the iodized oil were detectable. It is of interest to note that the surgeon in this case, as in so many others in our experience, believed that he washed all of the opaque oil from the spinal canal at the time of operation, while subsequent examination showed that perhaps not more than one-third was actually removed.

CASE 4. H. J., a 25 year old clerk, showed intracranial iodized oil 4 years after lumbar subarachnoid injection of 3 cubic centimeters.

This patient entered the San Francisco Hospital in August, 1934, complaining of pain down the backs of both legs, for about 4 years. This developed gradually while he was working in a warehouse lifting heavy objects, and the pain was worse on the right side. Neurological examination disclosed no evidence of cranial nerve disturbance. The patient stated that he had had a few dizzy spells in the past but not in recent years. There was pain in the right sacro iliac region on flexion and extension of the trunk,

*Note by Dr. H. Fleming through whose courtesy this portion of the history was reviewed.



Fig. 2, left. Case 1. Intracranial lipiodol left for 4 years. This patient had 3 cubic centimeters of lipiodol injected into the lumbar subarachnoid space in November, 1934, no organic intracranial lesion found. At the present time

there are numerous globules of lipiodol scattered throughout the third and fourth ventricles, basal cisternae, and just below the base of the cerebellum. Globules apparently fixed. No cerebral symptoms. b, Lateral projection.

vascular disturbances, changes resulting from the lipiodol, etc. However after going carefully into the history of the attacks, it was my opinion (E. J. M.) that there was a very large functional element present. It seemed very unusual that a patient, having the number of attacks which he claims and which were associated with loss of consciousness, did not report them to his physicians or to the insurance company further at no time did he receive any injury in the various falls.

Dr. Walter Schaller also examined this patient and found the neurological examination to be entirely negative. He stated that the attacks which the patient described, which were somewhat suggestive of epileptic seizures, were not due to any organic lesion and could not be the result of the intracranial lipiodol. He uncovered the fact which the patient previously denied, that he had sustained a former lumbar injury, for which he had been and still was receiving Veterans compensation. Proof that the cerebral symptoms were not the result of an organic cerebral lesion was the history given in March, 1930, that the dizziness and mental symptoms had disappeared following a second lumbosacral fusion.

CASE 2. S. L., 44-year-old female WPA worker showed intracranial lipiodol left 3 years after lumbar subarachnoid injection of 3 cubic centimeters.

(Walter Program Administration)

This patient entered the San Francisco Hospital in October, 1934, complaining of pain in the left upper abdominal region for 3 weeks. She is a 40-year-old lady, American born, who stated that in addition to the recently developed abdominal pain she had constant aching between the shoulders for 4 years, and numbness and tingling of the legs for 3 years. On further questioning she stated that she had had severe menstrual headaches for 3 years, dysuria for 8 years and, indeed, "most of the symptoms suggested to her such as palpitations, etc. Pelvic examination was negative. Roentgenographic examination of the spine was negative. Clinical diagnosis: Psychoneurosis, possible spinal cord lesion. On November 9, 1934, 3 cubic centimeters of lipiodol was injected by lumbar puncture. No abnormal findings were noted. One week following subarachnoid injection of the oil, the patient stated that she felt better since "the medicine the spine must be working. She is discharged much later, moderately improved.

Roentgenographic examination in June, 1935, revealed large collections of lipiodol in the cerebral ventricles and about the basal cisternae and subarachnoid spaces (Fig. 3).

Neurological examination in June, 1935, revealed that the cranial nerves appeared normal. Gait and speech were normal. There was no weakness of the muscles of the neck, shoulder girdle, arms, thighs, legs, or trunk. No atrophy as evident. The reflexes appeared normal. Except for small rashes on the back, just below the right scapula and corresponding to the fifth and sixth intercostal spaces, where there was slight hyperesthesia, there was no impairment of pain, light touch, position, or vibration. Clinically the patient had no new symptoms since myelography.

This patient had large amounts of lipiodol both intracranially and intraspinally for 4 years. She

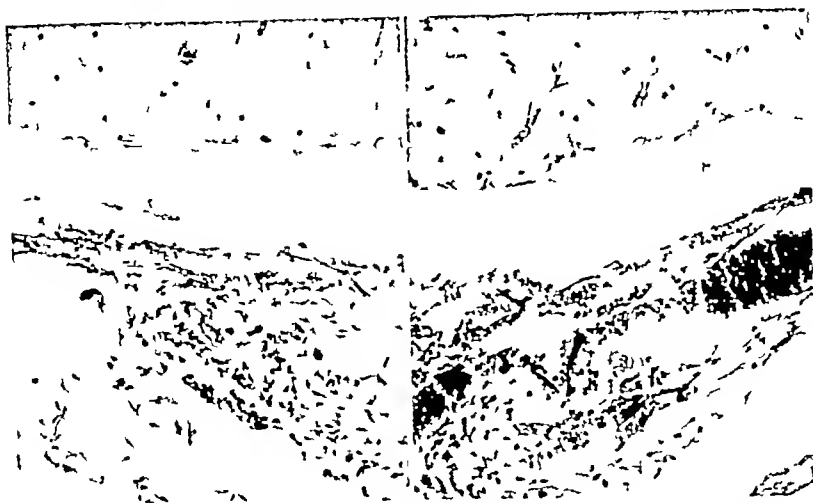


Fig 5 a and b Case 6 Sections from the arachnoid over the cerebellar hemispheres show fibrous proliferation, round cell infiltration, and a few foreign body giant cells containing minute fat droplets. There is no infiltration in the cerebellar cortex. Examination of similar areas over the cerebrum and cord also showed no microscopic evidence of infiltration (Dr Dock)

English. He dated his troubles back to 1931, when he apparently had generalized edema following some kind of acute renal illness. Since that time he had had intermittent inability to urinate. In September, 1935, he noticed poor vision in the left eye, examination revealed haziness of the disc margin and exudate. By December, 1935, he was practically blind in both eyes. Roentgenographic examination of the skull revealed a little calcification about the anterior horns of the lateral ventricles, thought to be due to calcifying ependymitis, and of the meninges over the tips of the frontal lobes. Encephalograms revealed no evidence of tumor. Following removal of 5 abscessed teeth he thought his vision improved.

Neurological examination in 1936 revealed diminished sensory responses to touch and prick below the level of the seventh thoracic segment, and just above that level a band of hyperesthesia. There was some lack of vibratory sense in the legs and diminished reflexes in the right leg. The following clinical diagnoses were made: Encephalomyelitis of unknown origin, chronic glomerulonephritis, possible spinal cord lesion at the level of the seventh thoracic segment. In February, 1936 3 cubic centimeters of lipiodol was injected into the lumbar subarachnoid space, no abnormal findings were noted. The patient's vision grew worse again, and neurological examination in March tended to confirm the previous clinical diagnosis of encephalomyelitis, and did not disclose any direct evidence of brain or spinal cord tumor. In May, 1936 the patient was discharged as improved; he could walk with crutches, his chronic glomerulonephritis and encephalomyelitis were somewhat improved, his optic neuritis was not improved. In November, 1936, he was readmitted to the Hospital in a sleepy condition, gradually became stuporous and died on December 16. No roentgenograms of the skull were made subsequent to the time of lipiodol injection.

Autopsy was performed and the general anatomical diagnoses were: chronic cystitis, pyelonephritis, multiple renal abscesses, bronchopneumonia, fibrinous pleuritis, and acute tracheobronchitis. The findings in the central nervous system were bizarre and are reported in detail.

The cerebral convolutions appeared normal. In the meninges along both sides of the pons there were numerous tiny yellow "crumbs," non adherent and lying on and under the arachnoid, these "crumbs" were made up of yellow spots and granulations. Similar yellow spots were seen on the arachnoid over the chiasm, the cisterna cerebellomedullaris, and the inferior portions of the cerebellar lobes. These varied from 1 to 2 millimeters in thickness, were lightly adherent and easily moved with a probe. There were yellow spots under the spinal dura and lightly adherent to the arachnoid of the lower 5 centimeters of the cord, being especially abundant on the conus and among the filaments of the cauda equina (Fig 4). Smears of this yellow material and its adjoining granulations stained with sudan or Nile blue and hematoxylin showed many fatty globules and fat staining crystalline burrs, with many round cells in clumps and sheets. On cutting the brain, the lateral ventricles appeared normal in shape and volume, but their lining was coarsely granular. The granules were white and glistening, in one area in the left anterior horn there was a pale yellow tinge to the granules. The choroid was not remarkable. In the white substance of the left frontal lobe, near the vertex, was a slightly raised brownish lesion, measuring approximately 2.8 by 1.8 by 1.8 centimeters. Sections showed this to be composed of glial tissue with some edema, the oligodendrocytes and vascular walls appeared normal, a few unaltered astrocytes were present in its center, and there was some extracellular lipid material. It was finally decided by Drs. Dock, Wood, and Usami that this lesion was an area of sclerosis of the brain of unknown origin, they did not think it was an infarct or xanthomatous plaque.

Sections of the brain stem, basal nuclei, cerebellum, and cervical spinal cord showed no noteworthy changes in the nervous elements. Sections of the lumbar cord showed some demyelinated fibers in both pyramidal tracts and in the anterolateral columns on the left side. There were small areas in the pia of the cauda equina in which giant cells, giant cells and fibroblastic proliferation about small vacuoles indicated the site of the yellow granules seen



Fig. 4. Case 6. Photograph and roentgenogram of the lower portion of the spinal cord of patient who had 3 cubic centimeters of Ipiodol injected one year previously. Light spots (Ipiodol) are present on and lightly adherent to the arachnoid over the lower 5 centimeters of the cord and the cauda equina. Microscopically, these are composed of fibroblastic proliferation about small acules, without any inflammatory type of reaction. Roentgenologically they show as punctate opacities. Similar globules of Ipiodol (with associated cellular reaction ("pseudogranulomas")) are present in the meninges over the base of the brain.

with local tenderness on pressure over the sacro-iliac joints. The reflexes and sensation are normal. Roentgenographic examination revealed no abnormal findings in the spine. The tentative clinical diagnosis as possible spinal cord lesion in the lumbar region. Lumbar myelography as performed in April, 1935, 3 cubic centimeters of Ipiodol being injected. This disclosed nothing definitely abnormal. Following this lumbosacral fusion was performed and the patient was discharged.

Roentgen examination of the skull in 1935 revealed the presence of one small droplet of oil in the cisterna chiasmatica, apparently fixed.

Neurological examination revealed no evidence of cranial nerve disturbance. The strength of the neck, shoulder girdle, trunk, and upper extremities as good and equal on both sides. Examination of the lower extremities was somewhat difficult because of pain associated with the

carrying out of the tests, but there was no definite evidence of motor impairment. No significant atrophy as present. The left knee and ankle jerks are slightly more active than the right, similar findings having been noted in 1934. No pathological reflexes are elicited. On questioning, the patient stated that since operation the pain had disappeared from the thigh but had persisted in the back, he thought he had one new symptom, namely that the legs had tendency to kick out convulsively 3 or 4 times when sitting or lying in bed. He had no new symptoms of intracranial origin.

This patient had collections of iodized oil in his cerebrospinal system, some of it in his cranium, for over 4 years. No clinical symptoms and no neurological findings attributable to the presence of this oil could be detected at the end of that time. There was only a little oil in the cranium at the time of examination in 1935, and it was apparently fixed.

CASE 5. I. B., 3 year old housewife, showed intra-cranial iodized oil 3 years after lumbar subarachnoid injection of 3 cubic centimeters.

This patient entered the San Francisco Hospital August, 1936, complaining of feeling of numbness and coldness over both hips for 3 months, of excessive and tendency to stumble, and of cramps in the right calf. She was pregnant at the time and, following delivery, month later was discharged with her symptoms improved but not entirely relieved. Re-examination next month following seizures with cramps in both legs revealed no evidence of pathological reflexes, although they were little hyperactive on the right side. Under tentative clinical diagnosis of space-occupying spinal cord lesion, lumbar myelography as done in October, 1936, 3 cubic centimeters of iodized oil being introduced by the lumbar subarachnoid route. The findings are negative. No operation was performed and the patient was discharged from the hospital slightly improved.

Roentgen examination of the skull in 1938 revealed small globule of oil in the region of the cisterna posterior, apparently fixed.

Neurological examination in 1938 revealed no evidence of disturbance involving the cranial nerves. The reflexes appeared normal. About the region of the right buttock and upper half of the right thigh, roughly corresponding to the distribution of the lateral femoral cutaneous nerve, there was slight hypalgesia and hypesthesia. Otherwise sensation appeared normal. Symptomatically the patient felt that she was improved, dating her improvement to hysterectomy. She had no symptoms referable to her cranium.

This patient had a small amount of intracranial iodized oil for approximately 3 years. Clinically this was productive of no symptoms and no disturbances of neurological origin.

CASE 6. S. G. Hindu laborer had 3 cubic centimeters of Ipiodol injected into his lumbar subarachnoid space approximately one year previously. The patient died of independent causes almost one year following myelography and at necropsy Ipiodol as found intracranially and intraspinally.

This patient entered the San Francisco Hospital in January 1936, complaining of pain in the right leg and kidney trouble. He understood and spoke only a little

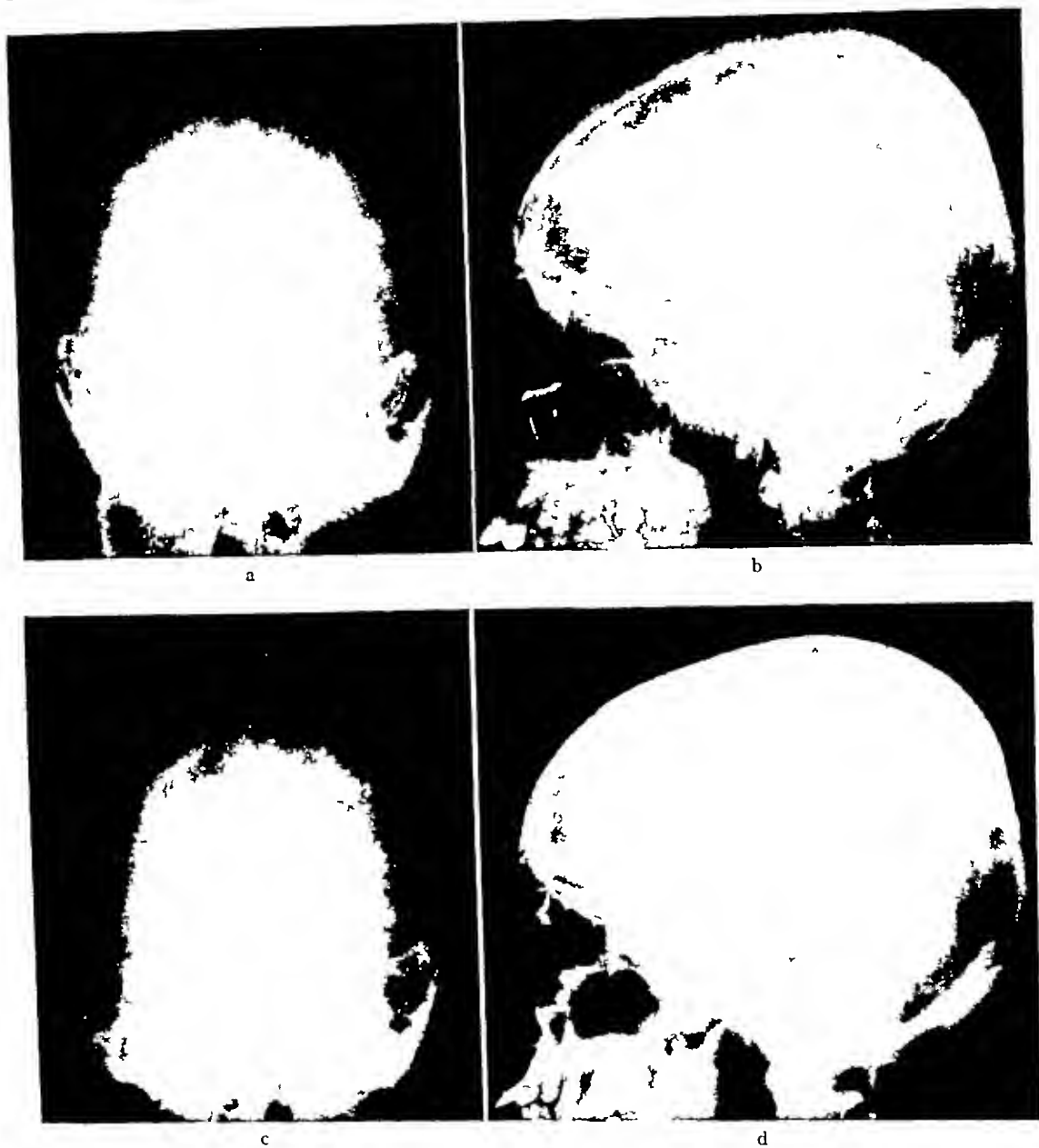


Fig 7 a and b. Case 9. Intracranial iodized oil for 2 hours and 1 week. (See also next illustrations). This patient had 3 cubic centimeters of lipiodol injected into the lumbar subarachnoid space to determine the presence or absence of a spinal cord lesion. These films were made 2 hours later, following maintenance of the patient in Trendelenburg position for a few minutes. Numerous

droplets of oil are seen scattered through the posterior fossa and about the basal cisternae, without producing any symptoms. The lipiodol moved freely. c and d, Same case. Intracranial iodized oil for 1 week. Residual droplets of opaque oil noted in and about the basal cisternae, 1 week following myelography. Most of these droplets were apparently fixed. No cerebral symptoms.

CASE 8. P. Z., a 37-year-old Swiss salesman showed intracranial iodized oil approximately one year after lumbar subarachnoid injection of 3 cubic centimeters.

This patient had severe pain low in his back radiating down the back of the right thigh and calf for a period of 5 months prior to admission to the San Francisco Hospital.

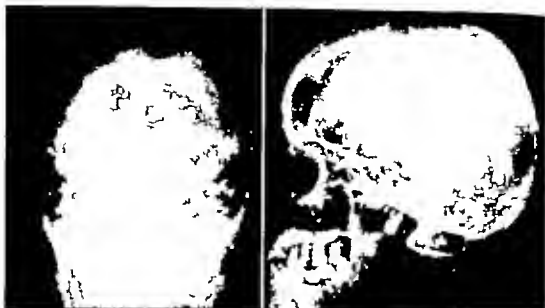


Fig 6 Case 7. Left: Intracranial iodized oil for 9 months. This patient had 3 cubic centimeters of lipiodol injected into the lumbar subarachnoid space in January 1934. At the present time there are numerous globules and droplets of oil in the posterior fossa, chiefly on the left side, and some in the left portion of the clisterna pontis. All of these globules are fixed. No clinical symptoms attributable to

the intracranial lipiodol. Note. In this patient, as in all of the cases illustrated, there are small amounts of opaque oil present in the lumbar and sometimes in other sections of the spinal canal. Most of these collections were fixed but some of the larger spinal collections or lakes could be moved. Patient had no symptoms referable to her cranial cavity. Right: Lateral projection.

grossly. There is scarcely any reaction of an inflammatory type. Similar reaction is seen in places in the meninges at the cerebellopontine angle close to the fourth ventricle. The thickened meninges of the region of the optic chiasm are spread out and stained pink. Masses up to 5 millimeters thick were seen, as well as many finer droplets, down to 5 microns. The meninges are very cellular, but these are nearly all young fibroblasts. No giant cells or round cells are seen (Fig 5).

The final diagnosis is: Sclerosis brain, left frontal lobe, localized, leptomeningitis, chronic, localized, with small collections of lipiodol in the meninges at the base of the brain and along the spinal cord; ependymitis granulosa; (b) calcification, in the anterior horn of the left lateral ventricle (Dr W. Dock).

This patient had 3 cubic centimeters of lipiodol injected into his lumbar subarachnoid space 10 months before death. Following that injection no symptoms or neurological findings attributable to the presence of the oil could be detected. At the autopsy it was suggested that some of the peculiar cerebral symptoms might be secondary to the lipiodol found scattered throughout the subarachnoid space, but detailed histological study of the brain and spinal cord revealed no lesions in the neural tissues proper which could be attributed to the lipiodol; the only changes of the latter type were confined to the meninges

and perhaps to the lining of the ventricles. The final histological diagnosis was multiple sclerosis and simple adhesive leptomeningitis.

Case 9. H. W., 30 year old housewife, showed intracranial iodized oil approximately one year after lumbar subarachnoid injection of 3 cubic centimeters.

This patient had severe backache and pain radiating down the right leg for over a year. There is no definite history of trauma. Following neurological examination it was deemed advisable to perform lumbar myelography. This was done in January 1935, 3 cubic centimeters of lipiodol being used. A posterior displacement of portions of the fourth lumbar disc, as diagnosed. This was reversed and the patient improved.

Röntgen examination in 1935 revealed the presence of numerous globules of oil in the posterior fossa and some in the clisterna pontis. There are also small lakes of opaque oil in the lumbar portion of the spinal canal and few droplets elsewhere in the spinal canal. The droplets are fixed, but some of the larger collections in the lumbar region are movable (Fig 6).

Neurological examination in 1935 revealed no findings attributable to the oil. The patient had no symptoms referable to her cranial cavity.

This patient had fairly large amounts of intracranial iodized oil for a period of over 9 months. No symptoms or signs attributable to this oil could be detected.

CASE 16 R. K., male, aged 33 years Intracranial iodized oil for 2 hours This patient had 3 cubic centimeters of lipiodol injected into the lumbar subarachnoid space 2 hours previously, a posterior displacement of the right side of the fifth lumbar disc was discovered The patient was not placed in Trendelenburg position, but, in spite of this, examination 2 hours later, following normal bed recumbency, revealed a few droplets in the region of the basal cisternæ and fourth ventricle, apparently movable No cerebral symptoms

SUMMARY

Our attention was called to the following facts first, that iodized oil may be found scattered throughout the subarachnoid space over the cerebrum and cerebellum, in the basal cisternæ, and even in the ventricles years after its injection into the lumbosacral sac, and, second, that these collections might account for certain cerebral symptoms In view of this, we studied a group of cases in which patients had had lipiodol injected at intervals of from 1 to 14 years Approximately two-thirds of this group showed collections of varying amounts intracranially A few of these patients, when re-examined, had symptoms and positive neurological findings indicating cerebral lesions However, a review of the histories and neurological examinations previous to injection of the iodized oil showed the identical symptoms and findings except in one patient in whom, as noted above, the complaints could not be substantiated by objective findings, were made by a patient proved to be a malingerer, and have since disappeared, following a second spinal fusion, therefore, in our opinion, they must be disregarded

The danger of drawing premature conclusions from the finding of iodized oil in the leptomeninges of the brain and spinal cord is well exemplified by Case 6 which came to autopsy In this case it was at first thought that the lipiodol was responsible for many of the patient's symptoms and positive neurological findings However, careful histological studies failed to reveal any cerebral or cord changes in the neighborhood of the oil and it is our opinion that these "lipiodol granulomas" have little or no clinical significance

In our series of cases it was noted that the intracranial lipiodol tends to become fixed, that is, immovable, whereas iodized oil in the spinal canal, especially when in large collections, is sometimes freely movable even up to a period of 14 years following injection Droplets tend to be fixed, collections of from 2 to 5 cubic centimeters movable

Another observation of note was that the removal of the lipiodol at the time of laminectomy is extremely difficult All of the cases in which

operation had been performed carried notations that the lipiodol had been "aspirated at the time of operation" Subsequent roentgenological examination of most of these patients showed a surprisingly large amount remaining in the cerebrospinal canal

So far we have no accurate explanation for the fact that only in two-thirds of the cases was the iodized oil found intracranially Whether this is connected with the patient's occupation or postural habits, involving frequent lowering of the head, remains to be determined, we are now conducting an investigation into this phase of the problem

CONCLUSIONS

1 Intracranial collections of iodized oil some years following lumbar myelography were found in approximately two-thirds of a series of 25 cases which we reviewed

2 In no cases were there any symptoms or positive neurological findings which could be ascribed to the presence of the oil

Since completion of this report, we have been informed that many leading neurosurgeons no longer incise the dura at laminectomy, in "disc and thickened ligament" cases, and leave the subarachnoid oil *in situ*

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TABLE I.—CASES SHOWING AMOUNT OF INTRACRANIAL OPAQUE OIL DISCOVERED BY ROENTGENOGRAPHIC EXAMINATION

Name	Age	Amount of oil in cranium	Interval between injection and examination of skull (years)
Cases showing oil <i>within</i> the cranium			
N S	7		3
J D	30		5
A C	30		5
S L	44		4
A J	40		4
H J	5		4
I N C	55		
M P	5		
L W	30		
I B	3		
L L	46		35
S G	38		
H W	30		
E Z	37		
W H	4		k
R K	33		day
Cases showing spinal oil but none <i>within</i> the cranium			
N B	6		7
M L	18		5
W M	56		5
C T	5		
G B	5		
I P	35		
P P	43		
P P	46		3
K McC	33		3 1/2

Amounts of oil in cranium are indicated as follows: —, normal amount; ||, moderate amount; ||||, fairly large amount; |||||, large amount. See also Tables.

In October, 1937, The pain followed fall from 5 foot wall. Roentgenographic examination revealed no abnormal findings. Clinically tentative diagnosis of retro-pulsion of the fifth lumbar disc was made. Lumbar myelography in October, 1937, with 5 cubic centimeters of oil, disclosed retro-pulsion of the fifth lumbar disc. At operation in October, 1937, this retro-pulsed disc as excised. The patient was discharged improved.

Roentgen examination in 1938 revealed several large globules scattered about the posterior half of the cranium, chiefly in the basal cisternae and above the tentorium, apparently fixed.

Neurological examination in 1938 revealed no evidence of cranial nerve disturbance except that the left pupil was slightly larger than the right; both pupils are regular and reacted to light and accommodation. A review of his findings in October, 1937, prior to injection of the oil, revealed that the left pupil was also larger than the right at that time. There was trophy and callosity of the muscles of the thighs and calves of the legs. The knee jerks were present and equal. The left ankle jerk as normal, the right as absent. No other abnormal reflex findings are noted.

This patient had intracranial collections of iodized oil for approximately 1 year. No cerebral symptoms or findings attributable to the presence of this oil could be detected.

CASE 9. W. H., 4 year old laborer, had 3 cubic centimeters of Ipiodol injected into the lumbar subarachnoid space shortly before examination.

This case is mentioned merely to illustrate the fact that maintenance of the patient in Trendelenburg position following lumbar injection of Ipiodol causes the oil to flow into the cranial cavity and that one week later following maintenance of usual bed rest or ambulatory position, only a little of the opaque oil may remain in the cranium (Fig. 7). These facts are of course well known, but are occasionally forgotten, since fluoroscopic examination of the calvarium is not performed routinely following myelography. We have seen intracranial collections of iodized oil as early as 2 hours following lumbar myelography in patients who were not placed in Trendelenburg position at all, and who stated they merely lay in bed, denying any marked head down position. This observation is made merely to bring out the fact that a Trendelenburg position is not always necessary to permit oil entering the cranial cavity. However, in most cases, the oil is not visible in the cranium following simple bed rest.

SYNOPSIS OF REMAINING CASES

CASE 10. N. S., male, aged 7 years. Intracranial iodized oil for 3 years. This patient had 3 cubic centimeters of Ipiodol injected by the lumbar route in 1934, at which time he had symptoms strongly suggestive of spinal cord lesion. The large amount of Ipiodol is said in error. At the present time he has large amounts of Ipiodol scattered through the lower cisternae, basal cisternae, and about the cerebellum. There is also later of about 3 cubic centimeters in the spinal cul-de-sac, still movable.

CASE 11. J. D., male, aged 30 years. Intracranial iodized oil for 5 years. This patient had 3 cubic centimeters of Ipiodol injected by the lumbar route in 1933. At the present time large amounts of Ipiodol are scattered through the cisternae and basal cisternae. No cerebral symptoms.

CASE 12. A. C., male, aged 30 years. Intracranial iodized oil for 5 years. This patient had 3 cubic centimeters of Ipiodol injected by the lumbar route in 1934. At the present time there are moderate amounts of oil in the basal cisternae. No cerebral symptoms.

CASE 13. L. L., male, aged 46 years. Intracranial iodized oil for 1 year. This patient had 3 cubic centimeters of Ipiodol injected into the lumbar subarachnoid space in April, 1937. At the present time there are 6 large globules in the base of the skull and about the cerebellum, apparently fixed. No cerebral symptoms.

CASE 14. M. P., male, aged 30 years. Intracranial iodized oil for 1 year. This patient had 3 cubic centimeters of Ipiodol injected by the lumbar route in 1936. At the time of examination of the skull moderate amounts of oil were noted about the basal cisternae and over the cerebellar lobes. No cerebral symptoms.

CASE 15. M. W., female, aged 50 years. Intracranial iodized oil for 1 year. This patient had 3 cubic centimeters of Ipiodol injected into the lumbar subarachnoid space in August, 1936. There are now small droplets in the region of the lateral venous sinuses, apparently fixed. No cerebral symptoms.

ANESTHESIA IN THYROIDECTOMY FOR THYROTOXICOSIS

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A STUDY of the various phases of anesthesia in thyroidectomy leads to the conclusion that in general the choice of the anesthetic agent is relatively unimportant, a much more important feature is the skill of the anesthetist and his knowledge of the physiological principles related to anesthesia. It is probably true, from the standpoint of mortality, that in no other disease is greater judgment in determination of operability, time for operation, and extent of operation required than in thyrotoxicosis. Although it is apparent that any of several types of anesthesia may be satisfactory, it is no doubt true that a surgeon and his anesthetist should choose one or perhaps two of the major agents and use them as a routine. However, it is preferable that the anesthetist be experienced in use of all accepted agents so others may be tried if the agent commonly used fails.

Since it is true that the patients' hyperexcitability, elevated basal metabolic rate, increased cardiac strain, etc., are important factors in the smoothness of convalescence from operations, it is naturally obvious that the choice of a routine in anesthesia which diminishes these undesirable features will lead to the most satisfactory results. Important in this consideration is the fact that toxic goiter is associated with an increased oxygen consumption, thereby making it necessary that asphyxia be avoided at all costs during the period of anesthesia, particularly since the anoxia incident to asphyxia is so apt to increase the tachycardia, to put a severe strain on the cardiac reserve, and to elevate the blood pressure. Anoxia likewise causes congestion and increases the tendency to bleed, thereby adding to the surgeon's difficulties. It becomes imperative then that asphyxia be avoided during thyroidectomy.

It should be realized that the purpose of anesthesia in thyroidectomy for thyrotoxicosis is not only to avoid pain but to eliminate the psychic trauma mentioned. If the latter feature is taken care of, a great deal will have been accomplished toward lowering mortality. From the standpoint of idealism, it would be desirable to have an agent which would neutralize toxicity. From our knowl-

edge at the present time this is impossible, unless depression of metabolism is equivalent to neutralization of toxicity. However, it must be realized also that the patient's inherent toxicity at the time of operation may be masked but probably cannot be neutralized with any type of anesthetic. Obviously, the mildly toxic patients will not sustain a sufficient amount of psychic trauma incident to the operation to do them any serious harm. It is in the severely toxic group that difficulties resulting in postoperative crisis, etc., will be encountered. A great deal of psychic trauma may be eliminated by adherence to the rule not to inform the patient of the time of operation except perhaps just at the time of operation. For years, Crile has emphasized the advantage of consulting the relatives, not the patient, concerning the operation, and performs the operation in the patient's bed. Crotti (6) likewise favors putting patient asleep in his bed but transports patient to operating room for the thyroidectomy.

If one of the gaseous agents—nitrous oxide, ethylene, or cyclopropane—is chosen, an attempt should be made to carry the patient in the lower border of the first plane of the third stage, representing the lightest degree of anesthesia which will abolish retching and vomiting, and yet allow the insertion of a pharyngeal airway. After this plane of narcosis has been obtained, it is our routine to insert a correctly curved pharyngeal airway whether or not obstruction has developed. An assured, clearly patent airway, however secured, is the principle upon which all good anesthesia is based. Absolute quiet and non-interference during the period of induction will in most cases eliminate the period of excitement, a complication to be avoided, particularly since safety in thyroid surgery is so dependent upon conservation of the patient's energy. The carbon dioxide absorption technique (Waters) aids in the maintenance of quiet, even respirations, and therefore should aid in the preservation of energy.

If ethylene or cyclopropane is used, the danger of explosions must be borne in mind constantly. Naturally, proximity of open flames, electric light switches, motors, etc., should be avoided. Of far more importance, however, is the danger of explosions from static sparks which may be created by contact of various objects including metal, clothing, etc., in the immediate environs of the gas

From the Department of Surgery and Division of Anesthesia, University of Illinois College of Medicine and the Illinois Research and Educational Hospital. Read before the meeting of the American Association for the Study of Goiter, Cincinnati, May 22-24, 1939.

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nearly 130 beats per minute, although the patients were only mildly toxic, and uncomplicated by hypertension or cardiac damage. Premedication so liberal as to secure mental tranquility may produce a depression greater than would have been exacted by the use of general anesthesia at the outset. To counteract psychic trauma, surgeons using local anesthesia rely upon various types of premedication. Hertzler has adopted a routine giving 4 grains of amytal the evening before operation and an additional 3 grains at six in the morning, an hour before operation the patient is given $\frac{1}{6}$ grain of morphine.

One of the great advantages of local anesthesia is the fact that as an anesthetic agent it is probably less toxic than any other anesthetic. The difficulty in eliminating the patient's apprehension and the slight inconvenience inflicted upon the surgeon, to a great extent neutralizes this advantage. The one definite indication for local anesthesia is obstructive dyspnea of such a nature that intubation is not feasible.

Although numerous modifications are utilized in infiltration of the procaine ($\frac{1}{2}$ to $\frac{3}{4}$ per cent), the principles are relatively the same. Pinching the skin gently for a moment before inserting the first needle will minimize the pain. The skin is infiltrated along the line of incision and then subcutaneously under the skin flap, but more particularly in the lateral directions to block the branches of the cervical nerves as they loop around the sternomastoid muscle. It is usually desirable to infiltrate the strap muscles so that they may be retracted without discomfort. A few cubic centimeters may likewise be injected into the upper pole and in the neck between the upper pole and trachea. Brenizer resorts to a more regional type of block by injecting laterally at the posterior border of the sternomastoid delivering procaine particularly at the sixth and second transverse processes.

Adrenalin should not be used with procaine (novocain) for thyroidectomy, because of the tendency to elevate blood pressure and likewise because of the possible relationship of adrenalin to ventricular fibrillation (Guedel). This condition may account for sudden death during operation, particularly in the patients who are greatly frightened.

Zellhoefer made a study of the healing of wounds after thyroidectomy in patients having a regional block on each side of neck, compared to the healing in patients having a local infiltration from the front. He concluded that healing takes place more smoothly when actual site of operation is injected with little or no anesthetic solution.

Sise (17) advises against local anesthesia, particularly in thyrocardiac patients because he has observed "venous congestion definitely to increase during operative procedures" during local anesthesia.

NITROUS OXIDE

Previous to the introduction of ethylene and cyclopropane, nitrous oxide was a popular anesthetic for thyroidectomy in thyrotoxicosis. Anesthesia with nitrous oxide permits an oxygen content in the gaseous mixture of less than 10 per cent, thereby tending to create a deficiency in a patient who needs a particularly large amount. Since cyanosis is so harmful to thyrotoxic patients and yet so difficult to prevent, a great many anesthetists and surgeons resorted to the use of ethylene or cyclopropane when these agents became available. Numerous workers have called attention to the tendency toward reduction of the alkali reserve following nitrous oxide anesthesia. With care in prevention of anoxemia, this phenomenon can be minimized.

Nitrous oxide is still being used by the majority of anesthetists in England, and by many anesthetists in this country. Waters (19) and associates favor nitrous oxide, but change to other agents as indicated. It is probably correct to state that to give nitrous oxide harmlessly in thyroidectomies for thyrotoxicosis requires enviable skill and experience.

From many standpoints nitrous oxide is a very desirable anesthetic. In the first place, it is non-inflammable—a feature possessed only by a few of the anesthetic agents. Since the maximum depth of anesthesia attainable even with adequate sedation is probably no greater than slightly below the middle of the first plane of the third stage, it is relatively harmless from the standpoint of actual toxicity through depth of anesthesia. Cyanosis, which is perhaps the greatest drawback to nitrous oxide anesthesia may occasionally be corrected by more premedication. More commonly, the anesthetist may change to a more potent agent, thus allowing more oxygenation.

ETHYLENE

It is possible to attain a depth of anesthesia down to the lower border of the first plane of the third stage with ethylene. This can be maintained with the maintenance of an oxygen mixture between 10 and 20 per cent. Toxicity of ethylene, as in nitrous oxide, is dependent upon oxygen deficiency, but with well timed premedication anoxia can be avoided. A disadvantage is the fact that it forms a violently explosive mixture with oxygen. We prefer premedication to consist of

machine. It is essential that no loose connections, particularly metal, be permitted anywhere on the gas machine but especially within the conduction system. During recent years static sparks have been responsible for practically all explosions. Still more important in the prevention of static spark than avoidance of loose connections, making and breaking contacts, etc. is the maintenance of a humidity of 55 or 60 per cent in the operating room. Thoroughly moistening the mask and rubber conduction system is likewise very essential. We subscribe to the conclusion expressed by Waters (18) that grounding of apparatus, floors, etc. will not diminish the hazard of explosions, but may increase it. Lahey has suggested an inter-coupling device to equalize the electrical charge of the table, gas machine etc. hoping that it will tend to minimize explosions.

Consideration of the *qualities desired in an anesthetic for thyroidectomy* reveals the obvious fact that none of the agents available fulfills all the requirements. It then becomes necessary to choose an agent or combination of agents which will meet as many of the following requirements as possible: (1) minimize psychic trauma (2) depress basal metabolism, (3) capable of rapid induction, (4) not elevate blood pressure or heart rate (5) avoid anoxia, (6) minimize laryngeal spasm, (7) sustain quiet respiration (8) be of relative low toxicity (9) have a wide margin of safety (10) conserve patient's energy

PREMEDICATION

Well chosen premedication drugs with proper dosage are of great importance in establishing a smooth anesthetic for the primary anesthetic agent. The purpose of premedication is to lower the metabolic rate and to abolish psychic trauma. To be ideal, such drugs should not depress the respirations beyond a safe level. The effect of these drugs is dependent upon the degree of thyrotoxicosis: patients with severe toxicity require huge doses. Morphine is one of the most valuable of the pre-anesthetic drugs, acting directly as a metabolic depressant and indirectly by minimizing emotional excitement. Atropine is valuable in premedication because of its inhibiting effect on secretion of mucous membranes, but it stimulates metabolic activity. It is, therefore, losing favor as a pre-operative drug in thyrotoxicosis. It is being replaced by scopolamine which inhibits mucous secretion as does atropine although it likewise acts as a metabolic stimulant, this action is largely neutralized by its reduction of emotional excitement. It is usually given in combination with morphine and when the two are balanced

(dose ratio 1:125) induction of a general anesthetic is greatly facilitated. However if the dose of scopolamine is too large a restlessness and even a mild delirium may rarely result, to be corrected by an additional small dose of morphine or $\frac{1}{16}$ grain of apomorphine. From clinical experience we avoid the use of scopolamine in elderly debilitated patients with thyrotoxicosis. Numerous routines are recommended for pre-operative drugs. Commonly pentobarbital sodium (nembutal) 2.5 grains or phenobarbital (luminal) 1.5 grains is given the evening before operation and a hypodermic of $\frac{3}{4}$ grain morphine with $\frac{1}{100}$ grain scopolamine given 60 minutes before operation the next morning. A dose of 5 grains of pentobarbital about 90 minutes before operation may aid in allaying apprehension and excitement and thereby allow the patient to take a better anesthetic. Sise (16) prefers 3 grains sodium pentobarbital by mouth $\frac{3}{4}$ hours before operation, followed by a hypodermic of $\frac{3}{4}$ grain of morphine and $\frac{1}{100}$ grain scopolamine about 45 minutes before operation (preceding cyclopropane anesthesia).

Of the group of drugs recommended as a basal anesthetic preceding general anesthesia, avertin, paraldehyde and sodium amytal are most commonly used. Avertin which is most popular is discussed in detail later. Because paraldehyde has very little depressant effect on respiration or the circulation, and has a wide margin of safety Marston has adopted it to precede nitrous oxide anesthesia: he gives 1 dram rectally for each 11 pounds of body weight 45 minutes before operation. Crile and Adams, however have reported a high incidence of pneumonia following paraldehyde: this complication is to be expected since the drug is eliminated by way of the respiratory system. Sodium amytal is rarely used as a basal anesthetic because of a toxicity greater than avertin given in doses sufficient to produce unconsciousness.

LOCAL ANESTHESIA

Although many surgeons use local anesthesia as a routine in thyroidectomy there is a far greater number who criticize it because of the severe psychic trauma which will be inflicted on the highly toxic patient during the operation. Perfect premedication is perhaps more essential with local anesthesia than with any other type. Unfortunately it cannot always be obtained because of difficulty in determining toxicity variability of individual reaction etc. A small series of cases studied by Brunner and Seed, in which premedication might be considered inadequate, revealed an elevation of the pulse rate during operation to

0.07 and 0.1 gram per kilogram, the dose being varied slightly with the toxicity of the patient. This dosage is sufficient to cause the patient to go to sleep, but naturally does not abolish pain, supplemental anesthesia is therefore required. Patients can usually be aroused after this dose but rarely remember incidents occurring during this period. Avertin lowers metabolic activity as well as blood pressure, both of these qualities are desirable in thyroid surgery. It is a respiratory depressant, and therefore might be an undesirable premedication in thyrocardiac patients in whom there is already difficulty in maintaining proper oxygenation. Since it is a respiratory depressant, many workers condemn or caution against the use of morphine with it. In analyzing 9 deaths in the literature following avertin, Heard noted that all except one had had morphine and finally concluded that morphine may have been an important factor in this death. If morphine is to be used, Heard recommends giving only 0.9 gram avertin per kilogram of body weight.

As is the case with premedication and anesthetic agents, avertin is used throughout the country in innumerable combinations with other agents. Keynes uses it as basal anesthetic preceding local anesthesia but not infrequently resorts to nitrous oxide before completion of operation.

An advantage often ascribed to the use of avertin in thyroid surgery lies in the fact that it decreases oxygen consumption and requires less of the accessory anesthetic agent. Heard noted that a mixture of 60 per cent nitrous oxide and 40 per cent oxygen was ample to maintain anesthesia after avertin. It has been our clinical observation that the decrease in minute volume of respiration produced by avertin tends toward a state of anoxia, measures must be taken to prevent this.

Experimental observations made by Arnheim and Tuckman (1) with avertin (0.1 gram per kilogram) in normal persons (not having operations at that time) should be very helpful in evaluating the disadvantages or advantages in thyroid surgery. They studied the reaction in 15 people, without premedication or supplementary anesthesia, and averaged the findings. They noted a drop of 24 millimeters in blood pressure and a drop of 22 per cent in the basal metabolic rate. The respiratory rate increased 6 per minute, but there was a decreased amplitude. The pulse rate increased 16 beats per minute, a finding which was borne out in our own studies with thyrotoxic patients during operation. Arnheim and Tuckman noted also that there was a drop of 1.8 degrees F in rectal temperature and a reduction of 3 minutes in the clotting time.

There was slight cyanosis in 2, and slight vomiting in 3 of the patients. The production of tachycardia and the occasional occurrence of cyanosis and vomiting would therefore be detrimental in the use of the agent as a basal anesthetic in toxic goiter. These defects probably more than neutralize the beneficial effects which might be ascribed to the drug as deducted from their experiments.

The fact that patients receiving 0.9 to 0.1 grain avertin per kilogram may be practically unconscious for 2 or 3 hours following operation may be an advantage or disadvantage in thyroidectomies depending upon circumstances. If the patient is in a charity hospital where nursing facilities and oxygen therapy may be inadequate, such complications as vomiting, respiratory obstruction, etc., may result in serious consequences. On the other hand, if the patient is particularly apprehensive and is able to have a private nurse, the abolition of memory during the first few post-operative hours will be a decided advantage, with adequate nursing care the dangers incident to vomiting and pharyngeal obstruction during the 2 or 4 hour period of semi-consciousness after operation will be minimized.

Clinical observation. In an attempt to evaluate avertin as a basal anesthetic in thyroidectomy for thyrotoxicosis we conducted a study in which we used avertin in 100 thyroidectomies. This series was almost evenly divided between toxic diffuse goiter and toxic nodular goiter. Dosage ranged from 60 to 90 milligrams per kilogram body weight, the average dose being 71.8 milligrams. All patients were premedicated. This consisted of 15 grains pentobarbital (nembutal) the evening before surgery and at 6 o'clock the next morning. A hypodermic of $\frac{1}{6}$ to $\frac{1}{4}$ grain morphine sulphate and $\frac{1}{150}$ grain of atropine was given one hour preceding surgery with no regard for time of avertin injection. In 4 cases this injection was given 20 minutes following the injection of avertin. No further fall in blood pressure or increase in respiratory depression was noted. Of the 100 patients observed 88 were asleep on reaching the operating room. These responded to external stimuli, but slept quietly when undisturbed. Eight patients were not asleep, but were drowsy, quiet, and co-operative. Four patients were mildly talkative, but showed no apprehension or rise in blood pressure. In these 12 cases the course of anesthesia was smooth. The average time interval between the injection of avertin and the surgical incision was 39 minutes. In all cases avertin anesthesia was supplemented with ethylene except for 11 cases in which nitrous oxide was

morphine and scopolamine. Thus a toxic thyroid patient might receive 90 minutes preceding surgery $\frac{1}{16}$ grain morphine / $\frac{1}{100}$ grain scopolamine to be followed in 30 minutes with $\frac{3}{16}$ grain morphine. This dose is, of course, varied, depending upon toxicity and the general condition and age of the patient. If desired, 15 to 3 grains pentobarbital (nembutal) may be given 2 hours before operation, in which case the dose of morphine and scopolamine should be decreased.

CYCLOPROPANE

This agent was introduced in 1939 by Lucas and Henderson. Much of the pioneer work in its pharmacology was done by Waters and Schmidt (21) who did a great deal to popularize its use. In spite of a huge number of reports available in the literature regarding the use of this agent, there are still innumerable points about which there is a total disagreement. One of the great advantages of the gas, particularly in thyroidectomies, is its potency which allows a large percentage of oxygen to be given. Six per cent or less of cyclopropane is sufficient to cause unconsciousness in the average individual (Seever, 14, and associates). Anesthesia can be carried all the way through the third stage with percentage no greater than 20 or 25 per cent cyclopropane. Induction is pleasant, there being no irritation to the mucous membranes unless the gas is used in concentrations greater than 50 per cent. The fact that respiratory failure occurs before cardiac failure fulfills one of the prerequisites of a safe anesthetic. The pharmacology and action of cyclopropane reported by American Medical Association's Council on Pharmacy and Chemistry (13).

There is no agreement as to whether cyclopropane is more apt to produce laryngospasm, shock, and circulatory collapse (factors particularly important in thyroidectomies) than other gases. It is well known however that bradycardia, arrhythmia, and tachycardia may be produced by the gas; the latter feature would, of course, be particularly detrimental in thyroidectomies since the patient is already suffering from tachycardia. Waters and Schmidt (21) warn that bradycardia and tachycardia are in reality expressions of over dosage and would, therefore, be inexcusable in thyroidectomies, since deep anesthesia is not needed in this work. In spite of the possible deleterious effect on the cardiac mechanism, Shee has expressed himself as favoring cyclopropane slightly over ethylene and to a great extent over local and nitron oxide in thyrocardiac patients, because of the advantage cyclopropane affords in its ability amply to maintain oxygenation.

One of the disadvantages of cyclopropane is the apnea and even asphyxia which may be associated with its use. The fact that the gas is not a respiratory stimulant is partly responsible for these features. The usual signs of anesthesia, described and recently standardized by Seever and Waters (15) are not of great use in cyclopropane anesthesia because of its peculiarities. Changes in heart rate as here mentioned may be the most reliable indication of a deep anesthesia. Movements of the eyeball are of only slight import in determining depth of anesthesia. Intercostal activity is of more value. In a large series of patients Waters (20) noted that nausea and vomiting occurred in 36.5 per cent of ether cases, 39 per cent of cyclopropane, 33 per cent ethylene, and 23 per cent of nitrous oxide cases. This relatively high frequency of nausea and vomiting constitutes a definite disadvantage in thyroid surgery because of the tendency of retching and vomiting to encourage postoperative hemorrhage. Some of the inability to standardize the various features in cyclopropane anesthesia may be due to the fact that in this gas at present time are great many isopurities many of which could not be classified as non-toxic. The highly explosive character of cyclopropane is an obvious disadvantage.

Because this agent is not a respiratory stimulant, many anesthesiologists and surgeons consider premedication drugs to be harmful since most of them actually act as respiratory depressants. This contra-indication to the use of premedication would appear to act as a disadvantage for cyclopropane in thyroidectomies, because it is so highly desirable to eliminate psychic trauma by premedication. In spite of the apparent danger of premedication with cyclopropane anesthesia, Shee (16) has noted no deleterious effects and recommends sodium pentobarbital (nembutal) 3 grains by mouth $\frac{1}{4}$ hours before operation and $\frac{1}{16}$ or $\frac{1}{100}$ grain morphine with $\frac{1}{100}$ or $\frac{1}{1000}$ grain scopolamine, 45 minutes before operation. Many anesthesiologists and surgeons including Shee (6), Goelach and others, use cyclopropane in thyroid surgery almost exclusively. Because of the numerous points of disagreement regarding the action and effect of cyclopropane, it is obvious that this agent should be used in thyroid surgery only by those highly trained in anesthesia as well as in the use of cyclopropane.

AVERTIN

Of the numerous basal anesthetics available, avertin is unquestionably the most popular and probably the safest. It is given rectally 25 to 30 minutes before operation in doses between

0.07 and 0.1 gram per kilogram, the dose being varied slightly with the toxicity of the patient. This dosage is sufficient to cause the patient to go to sleep, but naturally does not abolish pain, supplemental anesthesia is therefore required. Patients can usually be aroused after this dose but rarely remember incidents occurring during this period. Avertin lowers metabolic activity as well as blood pressure, both of these qualities are desirable in thyroid surgery. It is a respiratory depressant, and therefore might be an undesirable premedication in thyrocardiac patients in whom there is already difficulty in maintaining proper oxygenation. Since it is a respiratory depressant, many workers condemn or caution against the use of morphine with it. In analyzing 9 deaths in the literature following avertin, Heard noted that all except one had had morphine and finally concluded that morphine may have been an important factor in this death. If morphine is to be used, Heard recommends giving only .09 gram avertin per kilogram of body weight.

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Experimental observations made by Arnheim and Tuckman (1) with avertin (0.1 gram per kilogram) in normal persons (not having operations at that time) should be very helpful in evaluating the disadvantages or advantages in thyroid surgery. They studied the reaction in 15 people, without premedication or supplementary anesthesia, and averaged the findings. They noted a drop of 24 millimeters in blood pressure and a drop of 22 per cent in the basal metabolic rate. The respiratory rate increased 6 per minute, but there was a decreased amplitude. The pulse rate increased 16 beats per minute, a finding which was borne out in our own studies with thyrotoxic patients during operation. Arnheim and Tuckman noted also that there was a drop of 1.8 degrees F in rectal temperature and a reduction of 3 minutes in the clotting time.

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The fact that patients receiving .09 to 0.1 gram avertin per kilogram may be practically unconscious for 2 or 3 hours following operation may be an advantage or disadvantage in thyroidectomies depending upon circumstances. If the patient is in a charity hospital where nursing facilities and oxygen therapy may be inadequate, such complications as vomiting, respiratory obstruction, etc., may result in serious consequences. On the other hand, if the patient is particularly apprehensive and is able to have a private nurse, the abolition of memory during the first few post-operative hours will be a decided advantage, with adequate nursing care the dangers incident to vomiting and pharyngeal obstruction during the 2 or 4 hour period of semi-consciousness after operation will be minimized.

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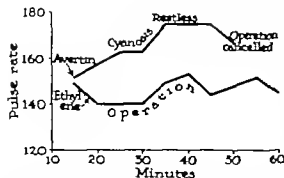


Chart. The upper graph represents the pulse rate of Case after being sent to the operating room after veritin (70 milligrams per kilogram). Under observation the patient's pulse rate, cyanosis, and restlessness increased, operation was therefore cancelled. The lower graph illustrates the pulse rate during operation under ethylene without veritin, 4 weeks later. The pulse rate revealed practically no real convalescence as relatively uneventful. Comparison of the two curves indicates that veritin detracted markedly from the patient's operability.

used. In no case was the preliminary incision made under avertin anesthesia alone. Approximately the same interval elapsed between the induction of gas anesthesia and the beginning of surgery as in cases in which avertin was not used.

Perusal of the changes in blood pressure and pulse in patients having thyroidectomy for toxic goiter (about equal number toxic and diffuse) reveals a definite tendency for avertin to prevent the increase in blood pressure which is so commonly noted in thyroidectomies without avertin (Table I). In each series ethylene was the anesthetic used except in a few instances when nitrous oxide was used.

The average elevation of the systolic blood pressure from the pre-operative level (on the ward) to the level of the average during operation in the group not having avertin was 17 millimeters. In the patients having had avertin, there was actually a drop of 3 millimeters showing that the tendency toward lowering of the blood pressure by avertin was equal to 20 millimeters. The pre-operative pulse (on the ward before coming to the operating room) rose from 93 to 100 in the non-avertin group, whereas it rose from 100 to 123 in the avertin series. The pulse rise was, therefore, 6 beats more in the avertin series than in the non-avertin series. This would indicate that perhaps a slight load was inflicted on the cardiac mechanism by the avertin. The pulse pressure in the non-avertin series was 56 before operation, and 63 during operation. In the avertin series the pulse pressure was 73 before operation and was reduced to 67 during operation. This

TABLE I.—EFFECT OF AVERTIN ON BLOOD PRESSURE AND PULSE

	Systolic blood pressure			Pulse		
	Pre-op. 120	Oper. 127	Time 17	Pre-op. 93	Oper. 100	End
Avertin 200 cases	148	154	—	100	123	—

indicates that avertin exerts a definite tendency to decrease the pulse pressure. All of the readings on blood pressure and pulse used in arriving at the figures quoted represented an average of 12 readings taken at 5 minute intervals beginning with induction of the anesthesia. Additional studies were made of the patients after operation. From the standpoint of pulse rate, temperature, length of hospitalization and complications, avertin appeared not to have the slightest effect on the postoperative course. In one of the few severely toxic cases in our series, protocol gives below avertin appeared definitely to produce detrimental effects including cyanosis, restlessness, depression of respiratory system, and elevation of pulse rate, thereby decreasing operability.

CASE. A white man, aged 23 years, No. 51521, had severe toxic goiter and right lobectomy had been performed August 9, 1936. In spite of bed rest, before, and after, etc., he failed to show any improvement or period of remission. On October 16, 1936, he is given 1/4 grain morphine and 1/30 grain atropine followed by 70 milligrams avertin per kilogram preparatory to removal of the second lobe. Upon arrival in the operating room he was restless, breathing rapidly and cyanotic. Pulse rate was only 120 and 70 (Chart I) but the blood pressure was only 120, the same as on the ward. During short period of observation, the pulse rose to 174 and restlessness as well as other symptoms increased. One of the most alarming features presented by the patient was definite cyanosis, resulting no doubt from the respiratory depressant effect of the veritin. The patient is obviously very poor operative risk, and the operation is cancelled. The patient recovered to his original condition after the avertin wore off but still remained severely toxic. On November 5, 1936, he was sent to the operating room again, receiving 1/4 grain morphine and 1/30 grain atropine, 1 hour before operation and 1/6 grain morphine, 30 minutes before operation which was done under ethylene anesthesia. He was fairly composed this time and received no cyanosis. The pulse rate ranged from 98 to 115 although the blood pressure was elevated to an average of 170/70. The remaining lobe was removed uneventfully the blood pressure dropping constantly during operation until at completion of operation it was 140/53. The pulse remained unchanged at about 120 throughout the operation.

It appears quite definite, therefore, that avertin detracted sharply from this patient's operability. Similar cases have been reported (Keyes) in which avertin appeared to aggravate the toxicity. Such a disadvantage although uncommon, is of

TABLE II.—EFFECT OF AVERTIN ON
THYROIDECTOMY

Advantages	Disadvantages
1. Decrease basal metabolic rate	1. Depress respiratory system (decrease minute volume respiration)
Decrease the rise in blood pressure	2. Encourage cyanosis
3. Abolish psychic trauma	3. Increase pulse rate
4. Less supplementary anesthetic required	4. Toxicity on liver and kidney
	5. More postoperative care required
	6. Occasionally encourages vomiting
	7. Occasionally reduces operability in the severely toxic patient
	8. Anesthetic deaths more frequent than with any other popular agent

which avertin was given at Massachusetts General Hospital, Beecher reports 7 deaths. This is classified by him as being a higher death rate even than the rate in chloroform anesthesia.

COMPLICATIONS

There are innumerable anesthetic complications which may arise during thyroidectomy many of these are the fault of the surgeon and not the anesthesiologist. Perhaps the most common is *obstruction*; this is rarely severe enough to cause alarm, except that even slight obstruction may lead to *asphyxia* a condition which is highly undesirable in thyroidectomies for toxic goiter because of the deleterious effect on the myocardium and of the tendency to increase hemorrhage and elevate the blood pressure. In most instances, obstruction will be of pharyngeal origin and can be corrected readily by adjusting the jaw and insertion of an airway. Not infrequently *laryngeal and tracheal spasm* will be the cause of the obstruction. This complication apparently may develop with almost any of the inhalant anesthetics. It is of reflex origin and caused by numerous factors (Cole 4) including too light anesthesia, starting the operation before proper anesthetic depth is attained, certain operative manipulations, particularly about the superior pole, and too sudden increase in concentration of the anesthetic agent. If these factors are borne in mind, the spasm will usually be readily corrected, particularly if the surgeon stops operating and relieves all possible sources of pressure and tension. On rare occasions tracheal intubation will be necessary. A much more serious cause of airway obstruction is that produced by *cord paralysis* created usually by operative trauma. Paralysis of one cord only will produce a variable amount

of obstruction, depending somewhat upon whether or not a spasm develops in the unaffected cord. If both cords are involved obstruction becomes so acute that tracheotomy may be necessary even before the operation is completed. If obstruction is caused merely by pressure of a clamp, removal of the offending clamp may eliminate the difficulty. Commonly it will be difficult to determine on the spur of the moment whether obstruction is caused by laryngeal spasm or cord paralysis. On such occasions intubation will usually be the procedure of choice. When the tracheal tube is removed, the surgeon should be available to do a tracheotomy if the airway cannot be re-established because of cord paralysis. Obstruction may, of course, be produced by rough handling of the gland, particularly if a large adenoma is located behind the trachea. Care in operative technique will eliminate this obstruction unless there is an actual atrophy of several of the cartilaginous rings. All patients should be questioned closely before operation as to the possible presence of obstructive symptoms produced by pressure of the gland, and x-ray films taken to determine the location of the trachea. If there is evidence or a significant history of obstruction, it will usually be preferable to intubate the patient after the anesthetic is started but before the operation is begun. Cyclopropane is of great value in affording anesthesia of sufficient depth for this procedure. Sise and Lahey have found helium to be helpful in minimizing the mechanical factor of obstruction.

The average patient with thyrotoxicosis does not tolerate very well the drop in blood pressure which follows *hemorrhage*. If, for some reason, hemorrhage has been profuse, measures, such as transfusion or intravenous glucose, should be taken early to maintain blood pressure.

Although *paresthesia* has been mentioned as a complication, it is extremely rare; it has been encountered only once in over 500 thyroidectomies.

SUMMARY

Because of its failure to abolish psychic trauma local anesthesia is criticized by most surgeons and anesthetists as being unsuitable in operations for toxic goiter unless premedication has been perfect. In the severely toxic patient it would not appear possible to eliminate this psychic trauma, even though premedication is ideal. Ether is rarely used because of the irritation to the respiratory tract and because surgical relaxation is not necessary in thyroidectomy. The gases, nitrous oxide, ethylene, and cyclopropane, are the most popular of the anesthetic agents. The

former is a desirable agent, but requires great skill in the art of anesthesia to prevent anoxemia which is so harmful to the thyroid patient

Exceptionally effective premedication is essential in the safe conduct of nitrous oxide anesthesia. Cyclopropane is the latest of the popular agents, is sufficiently potent to allow a very high oxygen content, but has the slight disadvantage of not being a respiratory stimulant and of producing changes in the cardiac mechanism when the toxic dose is approached. This is particularly confusing and undesirable in patients with auricular fibrillation or significant tachycardia.

Ethylene is sufficiently potent when preceded by adequate and well timed premedication to allow anesthesia without oxygen want and is not toxic, it is probably as safe as any agent for the average anesthetist. We prefer it to all other agents. As a premedication to the gaseous agents, $\frac{1}{4}$ grain morphine and $\frac{1}{150}$ grain scopolamine, varying dosage with toxicity, given 60 to 90 minutes before operation should be as effective as any Sodium pentobarbital (nembutal) in doses of 15 grains may be given 30 to 60 minutes before the hypodermic injection of morphine and scopolamine, the dose of which may then be reduced slightly.

Avertin is the most valuable of the basal anesthetics but never should be given in doses large enough to permit the operation to be performed without another anesthetic agent. The total abolition of the apprehension which might produce psychic trauma, the tendency to prevent elevation of blood pressure, and the decrease in basal metabolic rate incident to avertin anesthesia, are advantages in favor of the use of the drug, but do not neutralize the serious defects of respiratory depression, etc (see Table II). Occasionally, avertin may aggravate symptoms of toxicity, creating such a strain on cardiac reserve that operation may be fatal. If avertin is used, extreme care must be utilized in recognizing these instances and postponing operation. After analyzing our clinical experiences with avertin, we came to the conclusion that the disadvantages outweighed the advantages particularly because the drug appeared occasionally to aggravate toxicity in the severely toxic group of patients.

It should be emphasized that there is such a slight difference in the efficiency of the various anesthetic agents that good results may be obtained with any of those mentioned if care is used in its use, and work is confined to one agent to such an extent that the anesthetist and surgeon become well acquainted with its deficiencies. If a given anesthetic fails, the anesthetist should be prepared to resort immediately to another with the hope of eliminating the difficulty. One of the most important complications to be avoided is cyanosis.

Regardless of the agent used, it is extremely important that the anesthetist and surgeon cooperate fully in their effort to avoid operation on patients at a time when the patient's condition is too precarious because of toxicity, cardiac disease, etc, or his pre-operative preparation too inadequate to permit operation safely.

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OVARIAN AUTOGRAFTING FOR ENDOMETRIOSIS

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THE ravages of endometriosis in the pelvis of women confront the surgeon with difficult problems in judgment and method. If the pelvic structures are bound in the cul-de-sac of Douglas by dense adhesions and if the symptoms are severe, there are two surgical alternatives for arrest of the disease: (1) either postoperative irradiation of sufficient intensity to suppress permanently ovarian function, or (2) removal of the ovaries.

After either of these procedures, the surgical menopause promptly ensues, and for a high percentage of patients it is accompanied by distressing symptoms. Ovarian autografting is an uncommonly employed approach to the problem, the usual procedure being to rely on the administration of estrogenic preparations for control of the menopausal symptoms. Autografting has not been widely employed (1) in the treatment of endometriosis because of the general knowledge among surgeons that so long as diseased ovarian tissue is present *in situ* seeding of the pelvic peritoneum occurs with progression of the disease. However if the organs can be surgically separated, replaced, or removed, and all the sources of reimplantation can be eradicated, the estrogenic hormone may be present in the body without causing severe symptoms. If the structures are fused inextricably if the symptoms are severe, and if the risk of damage to the sigmoid and ureters is grave, irradiation is the simplest solution.

But when the pelvic organs and the diseased tissues can be removed, and fragments of normal appearing ovary are available, autografting is indicated. The procedure has produced satisfactory results in the treatment of 4 of 5 patients so treated. By means of this procedure, the disease can be arrested and ovarian function preserved with a negligible possibility of recurrence of symptoms and consequently need for subsequent laparotomy.

TECHNIQUE

The technique of autografting of ovarian tissue employed by most surgeons has been that described by Tuffier in 1906, and most operations (131) of this series of 36 have been done by this

method. It is performed by preparing, by blunt dissection, a site in the abdominal wall close to the incision. All bleeding points are carefully ligated. Into this bed is inserted the largest available fragment of normal appearing ovary. Because of the fact that the percentage of successes obtained by this type of procedure in the hands of many surgeons has been low the procedure for autograft has fallen into disuse. Microscopic studies made elsewhere on Tuffier grafts which had been removed while they were still functioning have demonstrated necrosis of their centers, the functioning tissue being confined to a narrow peripheral zone.

Since 1936 15 patients have undergone the operation for autograft at The Mayo Clinic by the method of multiple implantation the sites for the implantation of the grafts have been prepared as previously described. Five patients had endometriosis and 10 had oophoritis. Those portions of the ovaries which were free from disease were implanted after they were shaved into thin sections instead of being used in the form of segments. Two-thirds of the grafts for this group of 15 patients were successful.

ANALYSIS OF RESULTS

Autografting of ovaries is an old procedure. Authors whose contributions have been of considerable value are listed in references 1-10. Since it was first indexed at The Mayo Clinic in 1915 it has been performed for 136 patients, an average of about 6 operations a year for the 24 years. Table I shows the pathological status for which the autografting was done.

Follow-up data sufficiently complete to determine the fate of the autografts is available for 66 patients, or one-half the group of 136 patients. Thirty grafts, or 44 per cent of those performed, were successful. 38 grafts, or 56 per cent, gave no evidence of activity as reported by letter by the patients concerned.

Any one of four criteria were accepted as evidence of a successful graft: (1) relief of hot flashes with evidence of growth of the graft; (2) formation of a nodule at the site of the autograft manifesting a monthly enlargement; (3) periodic recurrence of menstrual moulins; or (4) menstruation, if the uterus was not removed.

From the Division of Surgery The Mayo Clinic and The May Foundation.

TABLE I—ANALYSIS OF 136 CASES OF AUTOGRAFTING OF OVARIES

Condition	Patients	Per cent	Patients traced	Per cent	Activity of autograft			
					Success	Per cent	No success	Per cent
Cystic, inflammatory ovaries	109	80	68	50	30	44	38	56
Endometriosis tarry or chocolate ovarian cysts	15	11						
Tuberculosis of pelvic organs (not ovaries)	2	1.5						
Anomalies of pelvic organs, dysfunction	2	1.5						
Benign tumors of ovaries	2	1.5						
Not stated	6	4.5						
Totals	136	100						

The average time that elapsed before there was evidence of activity of the grafts was 5 months. Vasomotor waves were observed of a high percentage of patients during this interval, but they disappeared with the first enlargement of the graft. Preservation of a menstrual rhythm has been noted in the patients who were successfully treated, characterized by the coincident enlargement of the nodes and the occurrence of the usual menstrual menses; this activity did not depend on whether or not the uterus had been totally removed. For the usual patient the nodes began to enlarge about 7 to 10 days before the date of onset of the expected menstrual period.

For women who have undergone successful autografts and from whom the uterus has been removed, the symptoms marking the menstrual time are usually brief. In most instances the length of the cycle has remained at about 1 month, although for a few patients it has become lengthened to 2 or 3 months.

The possibility of subsequent formation of cysts has long been a deterrent to the operation of autograft. Of 83 patients concerning whom data on this point were available, cysts of the grafts probably afflicted three. The largest of these cysts was described by the patient as being the size of a hen's egg; it persisted for 3 months. The relatively minor operation of removing an extraperitoneal autograft because of prolonged and painful enlargement was required for only 1 patient. Aspiration of such a cyst is usually sufficient to prevent excessive enlargement. No case of endometriosis of the site of the graft has been encountered thus far.

The average age of the group of 136 patients was 35 years. For the group of patients for whom the procedure was successful, the average age was 31 years, while for the patients who reported

no evidence of activity of the graft, the average age was 37 years.

Grafts have been placed between the peritoneum and the transversalis fascia, in the rectus abdominis muscle, above the sheaths of the recti muscles, and for one patient, on each cornu of the uterus. No evidence was uncovered in the course of this study to indicate that one site is superior to another for implantation. It is probable that grafts placed in rectus abdominis muscle are more tender than are those placed elsewhere, because of the mobility of that structure.

Data on the length of time elapsing before the appearance of the node are available concerning 9 patients; the average length of this interval was 5.3 months. Information as to the length of time elapsing between the operation and the onset of menstruation is available for only 2 patients; it was 4 months for 1 patient, and 5 months for the other.

The length of life of the graft is difficult to determine because data obtained by letter are often equivocal, because many of the most promising grafts are still functioning, and because data on all patients are not available. Some grafts have functioned for only 4 or 5 months, whereas 3 grafts have functioned 10 years or longer (10, 12, and 15 years). The average duration of activity of the grafts for 9 patients concerning whom accurate information is available was 5 years. Attention should be given to the fact that failure of viability of the graft does not mean that the operation was not beneficial, since most patients of this group were relieved of their pre-operative symptoms because of the surgical intervention performed for them.

Five patients suffering from endometriosis have undergone the operation for autograft performed by one of us (Counsellor) since 1936. All 5 of

these operations were done by the method of multiple implantation. Four of these 5 patients have obtained good results. The average age of patients of this group at the time of operation was 36 years. In each successful instance at least 2 grafts have remained viable. These 4 women were without symptoms, either of the primary disease or of ovarian insufficiency as determined by questionnaire on January 1, 1939.

SUMMARY

It is the consensus that the treatment of menopausal symptoms by the administration of the estrogenic hormone produces relief. As a corollary of this, employment of a harmless surgical procedure which provides estrogenic hormone is indicated. For 3 patients for whom treatment was successful, the amount of prolan and estrin excreted in the urine returned to normal values coincident with the enlargement of the nodes. Although some of the autografts may be insufficient to maintain normal values for estrin and prolan, they are sufficient to hold the symptoms of the menopause in abeyance to prevent atrophy of the genitalia, to maintain certain feminine attributes, and to allow a milder more natural type of menopause instead of an abrupt, severe, artificial menopause. Multiple implantation has been more successful than the method described by Tuffier in 1910. In selected instances, ovarian

autografting has the most to offer the unfortunate group of women who have a disease of the ovaries which cannot be arrested while ovarian tissue remains inside the abdomen. We see no other indi-

cation for its performance, because the efficiency of the implanted graft is certainly not that of the ovary which has its natural pedicle.

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SARCOMA OF THE ENDOMETRIAL STROMA

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Few attempts have been made to differentiate sarcomas which arise from the endometrial stroma from those which are primary in the uterine wall. Sarcomas of the uterine wall frequently, although not always originate in leiomyomas and assume the histological structure of a leiomyosarcoma, whereas endometrial sarcomas do not. Furthermore, little is known of the course and prognosis of endometrial sarcomas as compared to other neoplasms of the uterus.

Mayer in 1860 described 4 cases of polypoid sarcoma of the endometrium. He noted the similarity between the gross appearance of these lesions and that of certain carcinomas of the fundus of the uterus. In only one of these cases was there an exact pathological diagnosis and that was made by Mayer's brother in law, Virchow. The gross and microscopic appearance of endometrial sarcomas was first accurately described by Virchow in 1865. He pointed out that they could be either polypoid or infiltrative in character and that vaginal bleeding was often a prominent feature of the clinical course. He stated that the neoplasm was usually composed of round cells which often underwent myxomatous degeneration. Although metastasis of these sarcomas was rare, in his opinion the prognosis was poor because of the frequency of local recurrence. Virchow also described mixed sarcomas and carcinomas of the body of the uterus. There is little to add to his description of endometrial sarcomas, although it is likely that Virchow did not distinguish clearly between these neoplasms and leiomyosarcomas.

Since that time numerous reports on sarcomas of the uterine body have appeared, written by von Franque, Offergeld, Moench and Meeler, and others. Williams in 1894 collected 144 cases of sarcomas of the uterine body from the literature and of these the tumors in 44 instances were confined to the mucous membrane.

Although Williams believed that endometrial sarcomas were the commonest type of sarcoma found in the uterus, more recent authors have concluded that the majority of sarcomas of the uterus are of myogenic nature. It appears that

the earlier authors were influenced to a great degree by Virchow's writings on this subject. Misson found only 1 tumor of endometrial origin among 50 sarcomas of the uterus. Vogt (1923) reported 28 cases of sarcoma of the body of the uterus, only 8 of which could be traced as arising from leiomyomas. He did not classify the 20 remaining. Triml described 25 sarcomas of the body of the uterus in 15 of which there were no leiomyomas. It has been pointed out by Aisher, however, that sarcomas may arise from the uterine musculature in the absence of leiomyomas. In 11 cases of 13 sarcomas of the corpus uteri Wolfe found only 5 which had originated in leiomyomas. Kimbrough in 1934 reported a series of 38 sarcomas among which he had found 17 that did not originate in leiomyomas. Most of the 17 were situated in the mucous membrane of the uterus. Noval and Anderson in 1937 reported 5 endometrial sarcomas occurring among a series of 50 sarcomas of the body of the uterus.

Although endometrial sarcomas have been described as afflicting young women (Ward, 1931), the consensus is that they usually occur in older individuals. Kimbrough found that 75 per cent of sarcomas which did not originate in leiomyomas occurred in women past the menopausal age, whereas only 10 per cent were classified as afflicting women of the premenopausal age.

It is agreed by Williams, Misson, and Noval and Anderson that practically all endometrial sarcomas on gross examination form a polypoid tumor which projects into the uterine cavity, although occasionally they diffusely infiltrate the uterine musculature without forming a polypoid tumor.

Few groups of endometrial sarcomas have been collected which are large enough to provide an indication as to prognosis. Since the report by Lavis in 1920, most observers have felt that the number of mitotic figures discernible at histological examination is of definite value in estimating the rapidity of growth of sarcomas of the uterus. Kimbrough found higher counts of mitoses in the histological study of primary sarcomas (those not associated with leiomyomas) than in similar studies on sarcomas occurring in myomas. He felt that the prognosis was three times more favor-

able for a patient having a myoma undergoing sarcomatous degeneration than it was for a patient having a primary sarcoma.

In addition to cases of sarcoma of the endometrial stroma, a few cases have been reported in which the sarcoma was associated with adenocarcinoma of the body of the uterus (Gusnerow Goldstine).

Another group of neoplasms located in the uterine mucous membrane is the mesodermal mixed tumors. These tumors were first described by Anderson and Erdmannson in 1869 as occurring in the body of the uterus, a similar type of tumor has also been described as developing in the cervix. Excellent reviews on the subject have been published by Perlestein in 1919, Shaw in 1928 and Mefkle in 1936. These tumors are almost invariably polypoid in nature and are seldom infiltrating. Practically all those which have been reported have exhibited myxomatous degeneration of the cells. According to Glynn and Bell, cartilage and striated muscle are frequently present less commonly bone fat and nerve. Occasionally according to Nicholson, carcinoma is present in addition to the sarcomatous elements. Most patients, according to Mefkle, in whom mixed tumors of the body of the uterus have been found are of the postmenopausal age. A number of theories have arisen as to the probable histogenesis of this type of neoplasm. Wilms suggested that it originated from rests of the wolffian body. Others, including Wolfe felt that they represented teratomas. On the other hand, Nicholson in 1908 and Rankin and Broders in 1931 suggested that the process represented a dedifferentiation of the stromal cells of the endometrium to primitive mesenchymal cells from which there is differentiation to the various types of mesodermal tissue.

METHOD

A study from the gross and histological view points, was made of all tumors of the uterus which had been removed at The Mayo Clinic from 1904 to 1939 in which not only a diagnosis of sarcoma had been made but also in which there was any doubt as to the origin of such a lesion from a pre-existing leiomyoma. Many of these were leiomyosarcomas, but of this group 30 sarcomas of the uterus were found which were considered to have arisen in the endometrium.

All specimens were studied histologically by means of sections stained with hematoxylin and eosin where necessary special stains were employed. After the histological examination had been completed, the clinical records were examined and pertinent details tabulated.

GROSS APPEARANCE

In the series of 30 sarcomas of the endometrial stroma, the uterus was available for study in 10. In 13 of these uteri, the neoplasm presented itself as a polypoid mass projecting into the uterine cavity (Fig. 1). Invasion of the musculature was recognizable to the unaided eye in 4 of these sarcomas. In all cases except 2, the sarcoma was located in the region of the fundus. The 2 remaining were situated lower down in the uterus immediately superior to the external os. In most of the specimens of sarcoma of the endometrial stroma, the tumor was localized in one portion of the uterus and seldom involved the entire endometrium. Leiomyomas were present in 4 cases, but in all specimens they were histologically benign and in no way appeared to be connected with the malignant neoplastic process. Many of these leiomyomas were small, seldom being larger than 1 centimeter in diameter. An ovary in one case was involved by a fibroma, and several ovaries presented follicular cysts, but otherwise there were no incidental pathological findings. Most of the ovaries were atrophic, like those of women past the menopausal age.

HISTOLOGICAL APPEARANCE

The neoplastic cells were spindle-shaped on longitudinal section and round on cross section. Frequently there was ulceration of the surface with resultant infection of the tumor. The more rapidly growing neoplasms exhibited regions of necrosis. In one sarcoma of the endometrium there were numerous foreign body as well as giant tumor cells.

In many of the specimens there were varying degrees of myxomatous degeneration of the neoplasm. This myxomatous substance did not stain reddish with mucicarmine stain, as does the mucus secreted by epithelial cells. This type of degeneration was of value in distinguishing leiomyomas from sarcomas of the endometrial stroma, inasmuch as myxomatous degeneration rarely characterizes leiomyosarcomas.

All the sarcomas in this group were graded numerically according to the method of Broders. One was graded 1, 9 were graded 2, 6 were graded 3, and 4 were graded 4. Mitotic figures were demonstrated in all the sarcomas. There was considerable variation in the number of mitoses in the various tumors. Mitotic figures were more numerous in those neoplasms of high grade malignancy. Pathological mitotic figures were demonstrated in 7 of the 30 sarcomas.

There was a marked tendency in several instances for neoplastic cells to become grouped

around blood vessels. At times, this grouping was sufficiently marked to simulate the appearance of endothelioma or angioblastoma. However, other regions of the tumor could be shown to have the histological appearance of an endometrial sarcoma, and it was occasionally possible to trace the development of tumor cells directly from the cells of the endometrial stroma. It would appear that true endotheliomas are of rare occurrence in the body of the uterus.

Adult collagen fibrils were demonstrated in 2 instances. In both, the collagen fibrils were located between and were unquestionably formed by the neoplastic cells (Fig 2). Such an appearance is seen in the more differentiated fibrosarcomas and is convincing evidence that sarcomas of the endometrial stroma are fibroblastic in origin.

Invasion of the smooth muscle of the uterus was present histologically in all except 2 cases of that group of sarcomas in which the uterus was available for study. In several instances the process had extended through the entire thickness of the musculature, although serosal involvement could not be demonstrated in any specimen. Neoplastic cells occasionally could be demonstrated in the smaller veins and lymphatic vessels (Fig 3).

In 6 specimens it was possible to show the transition from normal stromal cells to neoplastic cells (Fig 4, a and b). This transition was sharply defined histologically. In the tumor, in the vicinity of this transitional tissue, a few non-neoplastic endometrial glands could be found, but they were absent in the other parts of the tumor. That portion of the endometrium which was not



Fig 1 Sarcoma of the endometrial stroma (Case 17). The tumor is polypoid and is attached to the fundus of the uterus. A parovarian cyst is present on the left side.

involved by the neoplasm did not vary from normal in appearance. The majority of endometria were of the atrophic type occurring in women past the menopausal age.

Two of the 20 malignant tumors presented a histological picture similar to those described in the literature as mesodermal mixed tumors. One of these has already been described by Rankin and Broders as a fibromyxochondrosarcoma. This neoplasm was made up of myxomatous connective tissue containing islands of hyaline cartilage

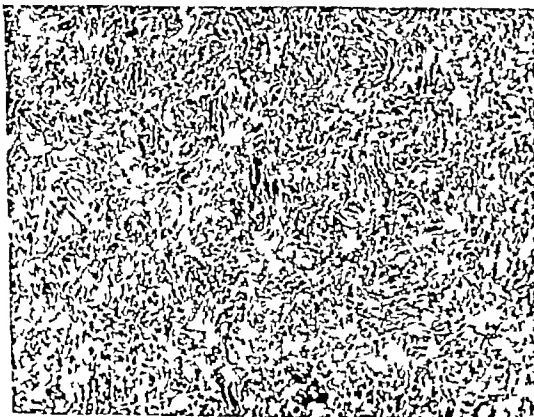


Fig 2 Sarcoma of the endometrial stroma (Case 14), showing the arrangement of adult collagen fibrils between the neoplastic cells. Hematoxylin and eosin, $\times 100$.



Fig 3 Sarcoma of the endometrial stroma (Case 6). The lymphatic vessels in musculature of uterus are filled with neoplastic cells. Hematoxylin and eosin, $\times 117$.



Fig. 4. a, left. Sarcoma of the endometrial stroma (Case 6) showing the transition between normal stroma of the endometrial tissue on the left, and the sarcomatous tissue



on the right, hematoxylin and eosin, X30. b, same specimen under more powerful magnification, showing glands in normal endometrial tissue: hematoxylin and eosin, X177

(Fig. 5) Both the fibroblastic and cartilaginous elements of this tumor were malignant, and were graded 3 according to cellular activity. In the other case (unreported) the tumor was a polypoid mass projecting into the uterine cavity. On histological examination it exhibited regions of fibrosarcoma, chondrosarcoma (both undergoing myxomatous degeneration) and adenocarcinoma (Fig. 6). Both the sarcoma and carcinoma were of grade 4 malignancy.

CHRONOLOGY AND SYMPTOMATOLOGY

The average age of the patients concerned in the entire group was 45 years. The youngest patient was 15 months old and the oldest was 71

years old. Nine out of the 20 patients were more than 50 years of age. The 2 patients who had chondrosarcomas of the uterus were 36 and 64 years old. Half of the 20 patients had been delivered of children: the average number of children born to a patient was 2.7. Ten patients are nulliparous.

The commonest symptom was vaginal bleeding or discharge: this symptom was present in 17 cases. The mass of the tumor could be visualized protruding through the cervix into the vagina in 3 cases. Frequency of urination was a symptom in 2 cases. An abdominal tumor could be palpated in 2 cases. The symptoms were of less than 1 year duration in 18 cases. In 1 case the symp-



Fig. 5. Fibrosarcomachondrosarcoma of the endometrial stroma (Case 9), showing the transition from fibroblasts to cartilaginous cells. Hematoxylin and eosin, X140



Fig. 6. Mixed sarcoma and carcinoma of endometrial stroma (Case 20). Note contrast between sarcomatous and adenocarcinoma cells. Hematoxylin and eosin, X140

TABLE I—DIAGNOSIS, TREATMENT, END-RESULTS SARCOMA OF THE ENDOMETRIAL STROMA, 20 CASES

Case	Pathological diagnosis and grade of tumor	Treatment	End results	Traced	Not traced	Died after operation
1	2 fibromyxosarcoma	Hysterectomy	Living 6 years	1		
2	1 fibromyxosarcoma	Hysterectomy	Living 6 years	1		
3	4, fibromyxosarcoma	Hysterectomy	Living 3 years	1		
4	2 fibromyxosarcoma	Hysterectomy	Died 6 years later no recurrence	1		
5	3 fibromyxosarcoma	Hysterectomy	Died	1		
6	2 fibromyxosarcoma	Hysterectomy	Died	1		
7	2 fibromyxosarcoma	Hysterectomy	Died after operation			1
8	3 fibromyxosarcoma	Hysterectomy roentgen ray	Died	1		
9	4 fibromyxosarcoma	Hysterectomy (elsewhere) radium roentgen ray	Died	1		
10	4 fibromyxosarcoma	Hysterectomy	Died	1		
11	3 fibromyxosarcoma	Hysterectomy (elsewhere) radium	Died	1		
12	3 fibromyxosarcoma	Hysterectomy	Died	1		
13	3 fibromyxosarcoma	Hysterectomy	Living, metastasis to 1st thoracic vertebra	1		
14	2 fibromyxosarcoma	Biopsy radium roentgen ray	Died	1		
15	2 fibromyxosarcoma	Removal of tumor radium	Died	1		
16	3 fibromyxosarcoma	Removal of tumor radium	Died after operation			1
17	2 fibromyxosarcoma	Hysterectomy radium	No record		1	
18	3 fibromyxosarcoma	Hysterectomy	No record		1	
19	2 fibromyxochondrosarcoma	Hysterectomy	No record		1	
20	4 fibrochondrosarcoma and adenocarcinoma	Hysterectomy	Lived 1 year	1		
Totals				15	3	2

toms were of 2 years' duration, and in another of 3 years' duration

Hysterectomy was employed as the sole treatment in 13 instances. In 4 others, it was combined with roentgen-ray treatment and radium. In 3 instances, radium was used without hysterectomy after removal of the tumor or a specimen of it for biopsy.

END-RESULTS

Death occurred after operation in 2 instances, a surgical mortality of 10 per cent. One of these deaths (Case 7) was caused by pneumonia following panhysterectomy, the other (Case 16) occurred following the vaginal removal of an ulcerated and infected tumor which protruded through the cervix into the vagina.

Of the 18 remaining patients, 2 (Cases 1 and 2) were living and well at the end of 6 years. One patient (Case 4) died 6 years following hysterectomy for sarcoma of the endometrial stroma, death being caused by a streptococcal sore throat, with no evidence of a recurrence of the

malignant neoplasm. One patient (Case 3) was living, with no demonstrable recurrence, 3 years after operation, although chronic cystitis was present. One patient (Case 18) was observed too recently for us to draw any conclusions as to longevity. Nine patients died, death being the result either directly or indirectly of recurrences of the neoplasm, at periods varying from 3 months to 4 years, following operation. Only 3 of these 9 patients lived 1 year or longer. One patient—still living (Case 13)—was afflicted by transverse myelitis in the thoracic region 11 months following total hysterectomy, a condition which biopsy proved to be the result of metastasis from the uterine sarcoma. One of the patients who had mixed mesodermal tumors was not traced, while the other (Case 20) was living 1 year following surgery. Pathological diagnosis, treatment, and end-result for each of these 20 patients are presented in Table I.

The grade of malignancy can be correlated with the end-results only in cases in which the patients

were traced. Of the 18 patients who survived the initial surgical treatment, 15 patients were traced, while 3 were not traced. Only 1 sarcoma was graded 1 according to cellular activity. The patient afflicted by this sarcoma was living 6 years after operation. Of the 5 patients who had sarcomas of grade 2 malignancy, 1 was living 6 years and another 2 years, after operation. 1 died of a recurrence 1 year after operation, 1 died of a recurrence 1½ years after operation, and 1 died of a recurrence 4 years after operation. Five patients had a sarcoma that was graded 3. 4 of these 5 patients died at periods ranging from 3 months to 7 months after operation. One of these 5 patients had a proved metastasis 1 month after the initial treatment, although still alive.

Four patients had a grade 4 sarcoma. One of these 4 patients was living and well 3 years after hysterectomy, 2 died 4 and 6 months, respectively following the operation. The fourth patient, who had a fibromyxochondrosarcoma and an adenocarcinoma was living and well 1 year after surgical intervention.

COMMENT

Although the gross appearance of the majority of endometrial sarcomas is typical, a polypoid tumor projecting into the cavity of the uterus does not always prove to be an endometrial sarcoma. A small percentage of adenocarcinomas, particularly the more malignant ones, can present a similar gross appearance.

As has already been mentioned, an endometrial sarcoma should be regarded as a fibrogenic sarcoma rather than as a type of sarcoma *sui generis*. Two sarcomas in this group had become so differentiated that collagen fibrils had been formed. Furthermore the histological appearance of this type of tumor corresponds to the histological appearance of fibrosarcomas situated elsewhere in the body and the prognosis for both is the same. If this is true therefore, the cells of the endometrial stroma must be regarded as fibroblasts, although as such they are somewhat modified. An exception is encountered in considering the group of so called mixed tumors which invade the body of the uterus. In the two mixed tumors encountered in this series, there were regions of chondrosarcoma in addition to regions of fibrosarcoma. In addition, one of these tumors was reported as exhibiting grade 4 adenocarcinoma. It appears that these unusual tumors most likely arise by a process of dedifferentiation of the trophal cells, after which process differentiation takes place into various types of mesodermal

structures as has been suggested by various authors. In fact, it was possible in examining sections from both mixed tumors in this series to trace the fibroblastic cells to the point where they changed to cartilaginous cells. On the basis of such a demonstrated development, these particular neoplasms can be considered to be true endometrial sarcomas. It could be suggested that the presence of carcinomatous elements in one of these neoplasms implies a teratoid origin, as has been suggested by Wolfe. However, Nicholson has reported carcinomatous elements as occurring in these mixed tumors, and Gershow and Goldstine have reported them as occurring in the ordinary type of endometrial sarcoma. It would seem that the appearance of such elements is an incidental finding.

The symptoms of the patients in this group are very similar to those of patients having adenocarcinoma of the fundus of the uterus. After curettage, it may be impossible to make diagnosis on the basis of the tissue removed, because the polypoid tumor has a tendency to elude the curette, whereas adenocarcinoma does not.

Although only 9 of the patients in the series were more than 50 years old, in 2 others menopause had been induced by means of radium and roentgen rays, a total of 11 patients who could be considered as being past the menopausal age. This percentage of 55 is considerably lower than that of Kimbrough who found that 75 per cent of sarcomas that did not arise in leiomyomas afflicted patients past the menopausal age.

Because of superficial ulceration of the tumor accompanied by infection, vaginal removal of these tumors may result in a fatal infection. This happened to one of the patients in this series.

One of the striking features of this group was the high mortality resulting from recurrence of the neoplasm. Excluding the 2 patients who died after operation, 66.6 per cent of those traced died or suffered from recurrence. 20 per cent lived 6 years or longer. This high incidence of recurrence is referable not only to the high average grade of malignancy but also to the tendency of the neoplasm to invade the musculature and small blood and lymphatic vessels.

SUMMARY AND CONCLUSIONS

Twenty cases of sarcoma of the endometrial stroma have been described. Two of these sarcomas belong to the group of so called mixed mesodermal tumors. The majority of these sarcomas produced a polypoid tumor which projected into the uterine cavity. They probably

belong to the general group of fibrosarcomas, since they occasionally differentiate to form collagen fibrils. The commonest symptom was bleeding. There was a mortality of 66.6 per cent as a result of recurrence of the neoplasm among those patients who were traced.

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RHABDOMYOSARCOMA OF THE CORPUS UTERI

R. E. LEE GUNNING, M.D. and CHARLES A. ROSS, M.D. Galesburg, Illinois

RHABDOMYOSARCOMA refers to tumors containing striated muscle cells of embryonic type. Shaw speaks of a group of mixed tumors which he has classified according to location as grape like sarcomas of the cervix uteri, tumors of the corpus uteri of the general type which will be discussed in this paper, and sarcoma of the vagina seen most frequently in young children. He states that striated embryonic muscle cells, cartilage, fat, bone, and sarcoma cells have been found in these tumors. They all contain some type of heterologous tissue.

Of the 3 types mentioned by Shaw those of the corpus uteri are the least common. Including the case reported here, there have been only 5 cases in the literature. Rhabdomyosarcoma is rare in any organ of the body. Cohen could find only one case in 18,077 cases at the Philadelphia General Hospital. The bulk of this tumor was found in the right kidney region and did not originate from the uterus. Lochrane could find only 8 reported cases of rhabdomyosarcoma of the corpus uteri from 1890 to 1935. Since that time Morones and Rika have reported 1 case.

Many theories have been advanced concerning the pathogenesis of these tumors. That they may be a result of metaplasia from pre-existing smooth muscle either in the myometrium or the blood vessel walls has never been sufficiently proved. Anderson and Edmannson thought that the cross-

striated muscle cells had arisen out of the spindle cells of connective tissue in the upper and back part of the cervix and the lowest part of the corpus uteri. Shapiro believes that his case developed embryonic striated muscle cells from embryonic rests displaced in the downward growth of the wolffian duct. Glynn and Blair Bell have noted the presence of involuntary muscle cells as has Lochrane but regard them as embryonic cells from which the striated muscle cells originated. They explained this on the basis that plain and striated muscle cells arise from a common mesodermal embryonic type.

Several similar but not quite typical cases have been found in the literature. Harding and Hankins report a case of rhabdomyoma of the uterus in a negro girl of 3 years, which seemed to arise from the anterior wall of the uterus below the uterovesical fold. This tumor contained embryonic myoblasts in all stages of development. Reeb and Oberling reported a case of rhabdomyosarcoma and cylindrical epithelioma of the corpus uteri occurring in the same tumor. Their patient was 51 years of age and 4 years past the menopause. She died with vaginal metastases 2 months after a total hysterectomy. These last 2 cases are not included in the accompanying table, because of the atypical location of the first and the unusual pathology of the second. They may however very well be classified in the same general group of mixed tumors of the uterus.



Fig. Gross specimen showing uterus open with tumor attached to fundus.

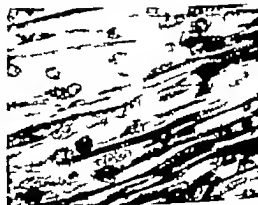


Fig. Photomicrograph showing many cells with marked cross striations.



Fig 3 Photomicrograph showing long, thick fibers with typical cross striations

CASE REPORT

A white female 58 years of age, married, with 4 living children was admitted to the St. Mary's Hospital January 2, 1939. She gave a history of her menses having ceased 10 years previously and stated that she had been in good health until 2 months before when she began to pass clots which at times had a bad odor. Physical examination revealed a robust Swedish female with normal temperature, pulse, and respirations. The blood pressure was 160/80 and her weight was 171 pounds, which was normal for her. Upon vaginal examination, the uterine fundus could not be made out, because of obesity. The cervical os was filled with necrotic tissue and blood clots. The urine had a specific gravity of 1.022, a trace of sugar and bile, the albumin was two plus, and there were 16 to 25 pus cells per high power field centrifuged. The blood count showed hemoglobin 96 per cent, red blood cells, 5,320,000, white blood cells, 6,700, polymorphonuclears, 60 per cent, eosinophiles, 6 per cent, and lymphocytes, 34 per cent. The blood Kahn test was negative.

From January 3 to January 5, the patient passed necrotic tissue resembling placental remnants which was too degenerated for microscopic examination. During this period, she developed a temperature up to 102.4 degrees that returned to normal when she stopped passing tissue.

On January 14, a supracervical hysterectomy and appendectomy were performed. The tubes and ovaries were normal and there were a few pericholecystic adhesions. The patient made an uneventful recovery. She was dis-

charged February 1 in good condition and has remained to date without evidence of recurrence.

The tissues removed were sent to the St. Francis Hospital in Peoria where they were examined by Dr. M. G. Bohrod to whom we are indebted for the following report:—

The specimen of tissue passed from the cervix was a mass of necrotic, slightly gelatinous material. On section, only occasional spindle shaped and oval cells were seen, but they were too indistinct for any adequate diagnosis.

The uterus was 6 centimeters long and had been amputated above the cervix (Fig. 1). The lumen was filled by a medullary gray, slightly gelatinous mass which had its origin from the posterior wall of the uterus extending laterally part way up both lateral walls. The surface was lobulated. On section, the tumor was found to be medullary and sharply separated from the muscle of the wall. There was, however, no capsule. Areas of necrosis were present but no hemorrhage. In spite of the sharp gross demarcation, sections showed incomplete separation between tumor and myometrium, groups of tumor cells extended into otherwise normal smooth muscle tissue. In the routine hematoxylin and eosin stains, the tumor cells varied in appearance from place to place and even in the same areas. They were round, spindle shaped or oval, had abundant but poorly demarcated cytoplasm and large vesicular nuclei. Nucleoli were prominent in most of the cells. Many of the nuclei were cigar shaped and looked very much like the smooth muscle nuclei of the myometrium. Fibrils were found between the cells and extending out from the more spindle shaped cells. It was obvious from the routine stains that the tumor did not resemble any of the well known tumors of the uterus. Very careful study disclosed a very few cells in which faint cross striations could be seen. Stains by Mallory's phosphotungstic acid hematoxylin and Heidenhain's iron hematoxylin, particularly the former, disclosed the true nature of the tumor. The cells showed very well defined cross striations. What was surprising, however, was the large number of cells which showed these findings. In previous reports only



Fig 4 Photomicrograph showing large protoplasmic cells with faint striations



Fig 5 Photomicrograph showing tubular cell with cross striations

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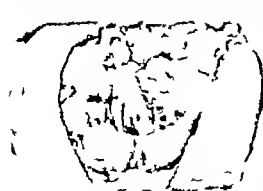


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TABLE I.—RÉSUMÉ OF REPORTED CASES OF RHABDOMYOSARCOMA OF THE CORPUS UTERI

Author	Date reported	Age, years	Post-menopausal	Prominent symptoms	Examination or autopsies	Treatment	Result and pathology
Gunning and Ross	1938	52	yes	Vaginal hemorrhage from vagina. Prolapsed tumor from vagina.	None to date.	Subtotal hysterectomy.	Good. Embryonic striated muscle fibers in tumor.
Morse and Roca	1938	50	no	Vaginal hemorrhage.	None.	Curettage, tracheotomy, total hysterectomy, postoperative therapy.	Good. Cellular polymorphism with giant cells in tumor. Embryonic striated muscle fibers in tumor.
C. D. Leach and	1933	58	yes	Vaginal hemorrhage.	None.	Curettage, postoperative therapy.	Good. Striated muscle fibers in tumor.
Shapiro	1931	52	11 yrs	History of uterine fibroid. Pain and vomiting. Loss of weight. Abdominal pain.	None mentioned.	Emergency hysterectomy.	Dead within 24 hrs. after operation. Embryonic striated muscle fibers in tumor.
Lewis	1928	60	6 mos.	Mild vaginal hemorrhage. Ulcerated enlarged base of cervix of evidence of malignancy.	T. abdomen.	Subtotal hysterectomy, lower total hysterectomy.	Dead 16 yrs. after first operation. Ulcerated base of cervix. Striated muscle fibers in tumor.
Glynn and Blair Bell	1934		30 yrs	Benign-looking vaginal discharge 24 mos. Prolapsed tumor from vagina.	T. abdomen and abdomen.	Total hysterectomy, postoperative therapy.	Unknown. Striated muscle fibers in tumor.
Glynn and Blair Bell	1934		18 yrs	Benign-looking vaginal discharge 24 mos. Prolapsed tumor from vagina.	T. lungs.	Curettage, hysterectomy.	Dead 6 mos. after hysterectomy. Striated muscle fibers in tumor.
de Franco	1893	48	10 yrs	Carcinoma vaginal flow with bad odor.	None mentioned.	Total hysterectomy.	Dead 10 mos. after hysterectomy. Striated muscle fibers in tumor.
Pyrenow and Edwert (quoted by von Fraunhofer)	1876		Postmenopausal.	Tumor attached by pedicle to base of uterus.	None mentioned.		Unknown. Completely developed cross-striated muscle fibers in tumor.
Anderson and Edwert	1889	30		White tumor mass found in vagina with finger-like excrescences extending from corpus uteri.	Examination, autopsy, after curettage.	Curettage, radical hysterectomy.	Dead of hemorrhage after hysterectomy. Incomplete absence of cross-striated muscle fibers in tumor.

small numbers, sometimes only rare cells, are seen with cross striations. In this case the majority of the cells showed processes with well marked cross striations (Fig. 3). Even the cells with cigar shaped nuclei which resembled smooth muscle cells, showed typical striations. Thick fibers like those seen in skeletal muscle are occasionally encountered. Often they were very long, crossing an entire low-power field of the microscope (Fig. 3). More common are thin fibrils, showing striations. Large protoplasmatic cells with faint striations are also present (Fig. 4). Mitoses are present in small numbers, but there are not single cells which showed both mitoses and striated fibrils. The cross striations, therefore, for the most part, occur in the longitudinal rows.

Of special importance are the presence of tubular cells with cross striations (Fig. 3). These resemble embryonic myoblasts.

The most difficult part of the pathological diagnosis is to think of the possibility of rhabdomyosarcoma. Appropriate stains will bring out the characteristic cross striations. More difficult is the

decision as to whether the tumor is malignant. Mitoses, by themselves, merely speak for the rapid growth and not necessarily for malignancy. The imperfect separation of the tumor and the myometrium indicates invasiveness. Of special importance are the tubular myoblasts which indicate the embryonic nature of the tumor. From the morphological point of view no decision can be made among the various theories for the origin and pathogenesis of rhabdomyosarcoma.

ANALYSIS OF CASES REPORTED ELSEWHERE

From a clinical and pathological viewpoint certain characteristics are common to these cases (Table I). They all occurred in women in the fourth decade or beyond—the oldest patient was 75 years of age and the youngest 49. Most were noted in patients past the menopause and

Franque's case occurred during the menopause and 1 patient, the case of Glynn and Bell, was 20 years past the climacteric. The early symptoms are usually vaginal hemorrhage and the passage of tissue from the cervix. Recurrences or metastases are mentioned in 4 of the cases and 4 of the patients died as a direct result of the rhabdomyosarcoma. One other patient died soon after a hysterectomy and the autopsy showed a chronic parenchymatous nephritis. The results were good in 3 cases, in 2 cases the results were not reported. Hysterectomy was performed in 7 of the cases, curettage in 4, enterostomy in 1, and roentgen-therapy was used in 1. Two had no operations reported. Striated muscle cells were found in all of the cases, but embryonic or degenerative changes were suggested in only half of the cases. They were undoubtedly present in all.

A routine search for cross striated muscle fibers in atypical sarcomas of the uterus may disclose the fact that these tumors are not quite as rare as the reported cases would imply.

SUMMARY

1 Rhabdomyosarcoma of the corpus uteri is a very rare tumor, only 10 cases having been reported to date.

2 A uterine rhabdomyosarcoma occurring in a 58 year old woman 10 years past the menopause is described clinically and pathologically.

3 A summary of the 10 typical cases which have so far been reported is presented and re-

veals the fact that these tumors occur in women past the menopause, that they are prone to metastasize, and that all contain embryonic forms of striated muscle cells.

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PHLEGMONOUS GASTRITIS

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IT is the purpose of this paper to describe again the disease known as phlegmonous or suppurative gastritis. The disease was observed by Galen and a diagnosis of cold abscess of the stomach was made by Petrus Forretus in 1597. Though the first pathological description was made in 1617 by Verandaeus (published in 1620 by Romani & Costa) and though the disease presents a classical picture, the physician is unable even today, to make a clinical diagnosis. A correct pre-operative diagnosis has been made only once in over 300 cases reported in the literature. A consideration of important data from the literature and a presentation of 3 additional cases are to be given here.

Definition. Phlegmonous or suppurative gastritis is a pyogenic infection of the stomach. It begins as a localized cellulitis which may become either a circumscribed abscess or a diffuse phlegmon.

Etiology. The most common organism causing this disease is the streptococcus. Sundberg reported streptococci in the gastric wall of 71 of 95 patients on whom bacteriological studies were made. Guy Meyer and Bruns recorded a case of streptococcus bronchopneumonia complicated by this condition. Direct contact with infectious material has been assigned as a cause of gastric phlegmon for example after tonsillitis, stomatitis, purulent bronchitis, drainage of oral abscesses, and tooth extraction. Gensler pointed out the possible significance of injury of the mucosa by chemicals, poisons of spoiled food, and even external trauma. He found instances of gastric phlegmon associated with ulcer or carcinoma of the stomach in over 50 cases. He observed that phlegmon of the stomach rarely occurs as a part of general sepsis. However Martland and Eisenberg mention several cases that were observed at topy during the epidemic of puerperal sepsis in Prague in 1847. It has occurred also following erysipelas and fungulosis. Lvall described a case of suppurative gastritis caused by penetration of the mucosa by a fish bone.

Sundberg found that there was hypo-acidity of the gastric secretions in all of his cases. Stieda has been quoted as having performed 64 gastric oper-

ations on patients with low acid values. Postoperative infections developed in 30 per cent while in 35 patients with high acid values only 2.8 per cent had complicating infections. Exhaustion from hard labor, alcoholism, chronic gastritis, and hypo-acidity of the gastric secretions are considered as predisposing factors to the disease.

Rankin and Miller and Lawrence have described cases of suppurative gastritis associated with cholecystitis and cholelithiasis. Lehnoff, Brooks and Clinton, and others have reported cases of phlegmonous gastritis developing in the presence of carcinoma of the stomach. Bircher cites gastric ulcer as the possible portal of entry for the infecting organism. MacAnley quotes Reeves as having shown that the blood vessels in the submucosa at the common sites for ulcer are longer, smaller and have fewer anastomoses than elsewhere in the stomach. He says that these vessels are more likely to be occluded by emboli and assumes that they are an important factor in the production of ulcer by hematogenous infections. It is proposed by MacAnley that this mechanism may obtain in the development of suppurative gastritis.

Incidence. Eliason and Murray Wright found that 83 per cent of cases of suppurative gastritis occurred between the ages of 30 and 60 years. Sundberg found that only 8 per cent of patients were individuals of the well-to-do classes of society, 25 per cent of them had indulged in excessive consumption of alcohol. It has been found that the condition is 3 times more frequent in men than in women (24). Lawrence in a review of 5,000 autopsies, found only 2 instances of gastric phlegmon.

Pathology. The suppurative process may occur in both a generalized and a localized form. It involves predominantly the submucosa but may extend into the muscularis and even involve the serosa. Perforation into the abdominal cavity usually results in a fatal peritonitis; the contents of the abscess cavity may be emptied into the gastric lumen by spontaneous perforation. In the generalized variety the inflammation extends from the esophagus to the pylorus and involves the entire stomach. As in our Case 1, relatively large collections of pus, 200 to 500 cubic centimeters, may accumulate in the submucosa. In the localized form, of which we are reporting 2 cases, either

Surgical Case of the Peter Bent Brigham Hospital and the Department of Surgery of the Harvard Medical School



Fig. Roentgenogram of the stomach, Case 1, four hours after single swallow of barium shows complete retention of the opaque material, loss of normal gastric rugae, and no evidence of peristalsis.

have been acute attacks lasting 2 to 3 weeks with a fatal outcome usually but occasionally undergoing spontaneous recovery after a protracted convalescence.

Olsson has described the roentgenological picture of phlegmonous gastritis as being characterized by loss of mucosal folds, presence of the mucous lining over the infiltrated area, often a complete gastric retention of ingested barium, and lack of peristalsis. In one of his patients a diverticulum-like deformity of the stomach was demonstrated by fluoroscopy. He warns that ulceration may be overlooked owing to alterations in the surrounding tissues.

TREATMENT

The mortality from phlegmonous gastritis has varied in different series of cases in the literature from 84 to 95 per cent. Eliason and Murray Wright reported 5 survivals out of 31 patients. Two of the survivals were patients having localized phlegmon. Gastric resection was performed in one of these and gastrostomy in the other. The other 3 patients had diffuse phlegmonous gastritis; simple laparotomy was followed by spontaneous recovery in 1 of these and gastrostomy was per-

formed in the other. Staplemon, Novak, Zepfel, and Guilbal have each performed gastric resection for localized abscess of the stomach with subsequent recovery. The diagnosis was either carcinoma or obstructing ulcer with perigastritis in 2 at the time of resection. Bovee performed an incision and drainage of a phlegmon of the stomach which resulted in recovery. The cures obtained by drainage and gastro-enterostomy have been considered by most authors as spontaneous recoveries. Gastric resection has been favored as the operation of choice for chronic circumscribed gastric phlegmon.

Acute phlegmonous gastritis may be a rapidly fatal disease, the patient dying within 48 to 72 hours after the onset of the illness. For this type of case only general supportive measures are indicated. However, if the patient survives the initial period of the disease and the condition improves as a result of conservative measures, exploration may be indicated on account of obstructive symptoms or persistence of infection. The use of the gastric tube and parenteral administration of fluid, salt, and dextrose are invaluable therapeutic agents. Operative drainage of the infected focus may be performed only where manipulation of the gastric wall, with adequate protection of the peritoneal cavity, is possible. Any operative procedure undertaken for such a condition is hazardous and the simpler the procedure the better. Gastric resection is contra-indicated. Spontaneous recoveries have occurred.

For chronic suppurative gastritis the initial problem is usually relief of alkalosis and pyloric obstruction. It is generally considered that patients recovering following operation did so in spite of rather than because of operation. This may be true so far as the infection itself is concerned, but the successful relief of pyloric obstruction is of undeniable benefit.

CASE 2. P. B. H. Surg. No. 57809. A student nurse, aged 22, developed an aching pain in the middle of the back and shortly thereafter became nauseated. She vomited about an ounce of orange colored fluid. During the afternoon she perceived freely developed headache, and had 4 watery bowel movements. Twenty-four hours later she had shaking chills and her temperature rose to 101.5 degrees F. Headache persisted and again the next afternoon chill occurred which lasted for 3 hours. She felt sensation in the epigastrium of lump moving up and down beneath the xiphoid. She was admitted to the medical service.

At this time the patient was ill developed, fairly well nourished young woman exhibiting marked malar flush. The temperature was 104 degrees F, pulse rate 90 per minute, and respiratory rate 20 per minute. The breaths were absent, but there was injection of the cheeks over the anterior pillars and the pharynx was quite red. There were several small, discrete, tender lymph nodes in the anterior

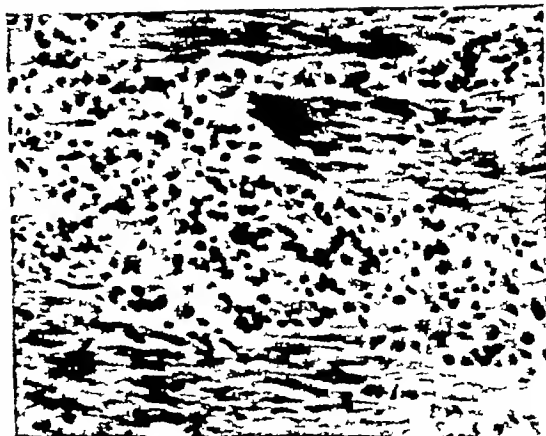


Fig 2 a, left Photomicrograph of section which shows extensive leukocytic infiltration and necrosis of muscle and submucosa $\times 200$ b, Photomicrograph of section

which shows no necrosis but the presence of a diffuse infiltration of polymorphonuclear leucocytes between the bundles of muscle. $\times 300$

cervical chain on the left. The abdomen was symmetrical in contour and not distended, no mass, spasm, tenderness, hernia, or fluid demonstrable by abdominal examination.

The urine was hazy yellow, alkaline in reaction, and had a specific gravity of 1.018, it contained the slightest possible trace of albumin, 2 to 3 white blood cells, many hyaline and granular casts. The hemoglobin measured 95 per cent, the red blood cell count was 4,500,000, and the leucocyte count was 14,800 with 87 per cent polymorphonuclear leucocytes. Repeated blood cultures were negative. A hemolytic streptococcus, among other organisms, was cultured from the throat.

During the first and second days the temperature varied from normal to 102 degrees. On the third day there was a recurrence of malaise, anorexia, nausea, and vomiting. Diffuse abdominal tenderness without muscle spasm gradually developed, this was most marked in the lower abdomen at first but later shifted to a localized band of tenderness extending from the left hypochondrium across the epigastrium to the right hypochondrium. The epigastrium became full but no definite mass was palpable. On the sixth day the temperature went to 106 degrees following a chill. The blood culture was again negative. The patient complained of a constant aching sensation in the epigastrium but the abdomen remained soft with the same distribution of tenderness. Pelvic examination at this time located only diffuse tenderness in both vaults and the presence of a creamy white vaginal discharge without pus cells but loaded with many gram positive cocci. She was placed in high Fowler's position and felt more comfortable. Vomiting persisted and the fluid intake was maintained by parenteral administration. The vomitus consistently was a green watery fluid containing no free hydrochloric acid and from 10 to 50 degrees of total combined acids.

Fluoroscopic examination of the chest showed the diaphragm to move equally and well on the two sides. There was no evidence of air beneath the diaphragm. Fluoroscopic examination of the abdomen 20 and 60 minutes after a single swallow of barium showed the barium to be completely retained in the stomach (Fig. 1).

From the ninth to the twelfth hospital day the temperature persisted at a level of 103 to 104 degrees. The white blood cell count fell during this time from 25,000 to 15,000 per cubic millimeter. The upper abdominal tenderness

became greater but still there was no rigidity of the muscles. Rebound tenderness became more striking and the pain was consistently referred to the left hypochondrium. There were ever increasing signs of peritoneal irritation and of a localized inflammatory process in the upper abdomen. Necessity for exploratory laparotomy became evident. Pre operative diagnosis, acute pancreatitis.

A midline epigastric incision was made, the stomach was found to be extremely reddened, thickened, and boggy to palpation. The liver and omentum were adherent to it. The former was freed and the lesser curvature investigated in search of a perforated ulcer, which was not present. The stomach, which was lying quite low in the abdomen, was lifted up and examination of the underlying intestines showed no evidence of a general peritonitis. A hypodermic needle was inserted into the stomach wall and a creamy white, non odorous pus was aspirated. An incision was made through the muscularis, which was about 1 centimeter thick, entering into a diffuse plane of purulent, viscid fluid. In this lake of pus, which was seen to lie between the muscularis and the mucosa, was a tough slough which was the remains of the submucosa. Material was obtained for microscopic study and culture. Thorough irrigation and aspiration of the infected submucous plane was performed after careful walling off for protection of the general peritoneal cavity. The suppurative process was not localized but seemed to surround the entire stomach from cardia to pylorus. The duodenum was normal in appearance and consistency, as were the gall bladder and pancreas.

Decision as to how to treat this unusual condition was quite difficult. That drainage of the suppurative process was necessary was obvious, but this would have to be done in such a manner as to protect the uninvolved peritoneal cavity. The only conceivable means of accomplishing this was to exteriorize the anterior wall of the stomach at the site of drainage. This was done by stitching the peritoneum to the stomach in the lowermost portion of the wound about the open infected sinus tract. The wound above this was closed with a continuous suture of silk and interrupted silk. The skin and subcutaneous tissues were left open. The gastric mucosa was not opened at any point during the operation. The patient withstood the procedure well considering her debilitated condition. A transfusion of 600



Fig. 3. The healed abdominal wound in Case 4, 4 months after operation. The gastric fistula closed spontaneously 6 weeks after operation.

cubic centimeters of citrated blood, as given and this, as followed by the administration of 3,600 cubic centimeters of parental fluids in the ensuing 48 hours. Postoperative diagnosis, acute septicemia, phlegmonous gastritis.

The next day her temperature was 38.8 degrees, pure growth of hemolytic streptococcus was obtained from the cultures of the pus in the gastric subincision. The administration of sulfanilamide subcutaneously, as immediately started, 5 grams, are given by hypodermoclysis on the first postoperative day and 8 grams on the second day. During the next 8 days maintenance dose of 4 grams daily, as administered via the same method. Blood transfusion was repeated on the fourth day. On the fourth postoperative day spontaneous perforation of the gastric mucosa occurred and the stomach contents began to drain into the wound. The wound, as kept dry by constant suction with perforated rubber catheter.

During the first 3 days after operation the temperature gradually fell from 106 to 100 degrees F. Thereafter it assumed an average elevation of 101 degrees for 1 week. The sulfanilamide content of the blood, as found to be 1 milligram per cent. It was discontinued after 5 days' administration as the patient, as constantly pyrexia.

The leucocytic count, which had risen to 35,000 to 40,000 during this period, 7 days after operation her temperature was 101.6 degrees and showed no further elevation during the remaining 33 days in the hospital. The drainage from the fistula had been 1 times as much as 3,600 cubic centimeters in 24 hours. It usually contained on free hydrochloric acid and very low total acid. On occasions it, as found, contain only 5 units of free hydrochloric acid. The blood vitamin C level, as found to be extremely low, .05 milligram per cent on the sixth day and daily administration of vitamin C intravenously, as instituted until it, as possible, began high-calorie and high-vitamin diet. The patient was discharged from the hospital 5 days

after operation, quite well except for very small wound tract that needed change of dressing only once daily.

Pathological report—microscopic examination. The most interesting sections are (Fig. 3) those from the antrum and from portions of the antrum of the stomach. Here there are extensive areas of complete degeneration and loss of structural detail. Such areas contained fairly hemolytic necrotic material, large numbers of polymorphonuclear leucocytes, and numerous cords in short chains. The areas of the muscular coat in addition to this acute inflammatory reaction showed several areas of granulation tissue in which there are numerous proliferating fibroblasts. Occasionally there are faint zones of collagen about single or small groups of fibroblasts. Dr. Wolbach, in reviewing these sections, as impressed by the lack of collagen formation by the cells of the granulation tissue. Such striking lack, in his opinion, was probably indicative of human C deficiency. Consequently he advised that the patient receive vitamin C in some form as part of her therapy. One large histologic section showed marked inflammatory reaction and intense infiltration with polymorphonuclear leucocytes.

Diagnosis. Acute phlegmonous gastritis due to hemolytic streptococcus, vitamin C deficiency.

The patient, as readmitted to the hospital for examination 4½ months after the beginning of her illness. The small gastric fistula had gradually closed during the last 6 weeks at home (Fig. 3). Her appetite returned and there was 30 pound gain in eight months, with return to normal strength. Gastric analysis at this time showed as free acid in the fasting contents or after as shocked but small, but after histamine 60 units of free acid was present in the first specimen and 70 units in the second specimen. The red cell count of the blood, as 3,500,000 and the hemoglobin measured 30 per cent. The blood vitamin C level was measured at .30 milligram per cent as contrasted to .05 milligram per cent 4 months previously, 10 days after operation.

The report of roentgenographic gastro intestinal series is as follows. The esophagus appeared normal. The stomach, as medium in position, smooth in outline with good peristalsis and normal rugae. There was constant swelling on the lesser curvature, the first portion of the antrum (Fig. 4) otherwise findings normal. The normal filling and emptying, the good peristalsis, and regularity of normal rugae are roentgenographic evidences of complete recovery.

Ten months after her illness the patient continues to be quite well and has resumed her duties as a student nurse. Gastric analysis now shows free hydrochloric acid content of 30 to 35 units in the fasting contents of the stomach and the blood vitamin C level is normal. She is entirely free of any abnormal gastric symptoms. Unusually is again.

Case 2. P.B.B. Surg. No. 59,504, 41 years, April 17, 1937, entered the hospital because of abdominal pain and vomiting of 6 days' duration. The patient had suffered with indigestion for 2 years. Eighteen months before admission he was examined in another hospital and treatment administered for duodenal ulcer with obstruction. At that time the gastric contents showed free acid of 50 degrees and total acid of 64 degrees. He was quite improved with diet and alkaline therapy. Fourteen months later he was treated on the surgical service of the hospital for duodenal ulcer with obstruction and alkalosis. Gastric retention of 500 cubic centimeters gradually developed to no retention after 2 weeks and the alkalosis cleared up at the same time. He was discharged after 2 weeks of treatment. Four months later he was admitted to the medical service with the complaint as mentioned. Again he was found to be in a state of alkalosis from persistent vomiting. Aspiration of the stomach contents yielded as much as 1,000 cubic centimeters of retained food at times. The

carbon dioxide combining power of the blood was 90 volumes per cent and blood urea nitrogen measured 59 milligrams per cent. After 1 week the patient was transferred to the surgical service.

At operation a hard, rubbery mass, which practically occluded the duodenum was found 1 inch below the pylorus. The gall bladder and omentum were adherent to this area and it was felt unwise to separate the adhesions. The stomach was large and on its anterior surface, 4 inches above the pylorus near the greater curvature, there was an inflamed, indurated area. The gastrosplenic omentum near this region was edematous. Incision was made into the inflamed gastric wall and a biopsy made, closure of the stomach wall was made with interrupted silk sutures. A posterior gastro-enterostomy was then made and the abdomen closed without drainage. The postoperative course was uneventful and patient was discharged 2 weeks later.

Pathological report—microscopic examination. The tissue removed from the wall of the stomach consisted of serosa and a portion of the muscular coat. There was no exudate on the surface. The serosa was edematous and was infiltrated with inflammatory cells which, for the most part, were eosinophils. Similar groups of cells were seen to extend between the bundles of muscle and to lie about the vessels. Similar cells were seen in the vessel walls in some places. No micro-organisms were demonstrated. The specimen represented a subacute inflammatory reaction in the muscular and submucosal coats of the stomach. A similar reaction might be found about the base of an ulcer or it might represent a more widespread reaction of gastritis. A section of lymph node showed no evidence of inflammation or tumor.

Diagnosis. Acute and subacute inflammation of the muscle and serosa of the stomach.

Four months after operation the patient is entirely well. He has gained weight and is working regularly. A gastro-intestinal roentgenographic series at this time shows that the posterior gastro-enterostomy is functioning well. There is no crater or tenderness present but the gastric rugæ appear definitely thickened and tortuous.

This case represents a mild form of the type of localized gastritis originally mentioned by Verandaus. It also serves to remind one of Cruvelier's hypothesis of the interrelationship of gastritis and ulcer.

CASE 3 P B B H Surg No 3684. A salesman, aged 34 years, entered the hospital complaining of "stomach trouble." For 6 weeks there was loss of appetite and for 4 weeks postprandial epigastric pain and vomiting. Soda did not relieve the pain and it was aggravated by all kinds of food. Pain and vomiting became progressively worse and the presence of coffee ground like material was noticed in the vomitus.

Upon physical examination the patient was found to be well developed and well nourished. In the epigastrium there was very slight spasm of the rectus muscles and some tenderness on moderate pressure. A positive guaiac test was found upon examination of the stool. Gastric analysis showed 52 degrees of free hydrochloric acid and a total acidity of 85 degrees. The gastric contents consisted of coffee ground like material. The leucocyte count of the blood was 14,800 per cubic millimeter, the hemoglobin measured 120 per cent, and the erythrocyte count was 5,752,000 per cubic millimeter. Four hours after administration of a bismuth meal there was a very large residue in the stomach visible by fluoroscopy. The stomach was low in position and appeared atonic. There was an irregularity



Fig 4. Roentgenogram of the stomach, Case 1, during a gastro intestinal series 4 months after operation shows a constant notching on the lesser curvature in the first portion of the antrum. Emptying of the stomach was normal at this time.

in the region of the pylorus suggestive of an ulcer in this region. The pre-operative diagnosis was that of ulcer on the lesser curvature of the stomach.

Operation was performed by Dr John Homans. The gall bladder was adherent to the base of the mesocolon. In the region of the pylorus the sphincter seemed unusually thick and blended into an area of induration which extended medially along the greater curvature for $\frac{3}{4}$ of an inch. At this region the stomach wall was thickened and felt like the induration of a carbuncle. The stomach was opened and the wall along this portion of the greater curvature close to the pylorus was found to be about 1 centimeter thick. The cut tissue had a grayish, granular appearance. A biopsy of the tissue was made and the pathologist reported a diagnosis of acute suppurative gastritis. In spite of the condition of the stomach wall a Finney pyloroplasty was performed. The operation was quite difficult owing to the thickness of the gastric wall. At completion of the plastic procedure there was a pyloric stoma which would admit 2 fingers.

Eighteen days later the patient was discharged in excellent condition. Roentgenographic examination of the stomach at that time after a bismuth meal showed only a small residue. The peristaltic waves were active. Six months later the patient had gained 30 pounds and had been at work 4 months without symptoms. Eight years later a roentgenographic gastro intestinal examination showed a residue of 10 per cent of ingested barium at 6 hours. The outline of the stomach was smooth and the pylorus was wide. The second portion of the duodenum showed a sharp kink but no dilatation to indicate obstruction. The impression was that the pyloroplasty was functioning well.

Histological report. The mucous membrane of the stomach was infiltrated with many polymorphonuclear leucocytes and round cells. The capillaries are dilated and there was some extra reaction of blood. The mucous membrane in places was ulcerated.

Diagnosis. Acute suppurative gastritis.

SUMMARY AND CONCLUSIONS

One of our patients, Case 1, had severe acute, diffuse phlegmonous gastritis owing to infection by a hemolytic streptococcus. Manipulation of the stomach and drainage of the infection, followed by administration of sulfanilamide, resulted in cure. We believe that adequate drainage of the suppurative process played the major rôle in the ultimate recovery of this patient but it is impossible to evaluate the effect of sulfanilamide and vitamin C. The finding of little collagen formation in the granulation tissue suggested to the pathologist the existence of a vitamin C deficiency which was corroborated by blood determinations. It is apparent that this deficiency developed during the acute illness; however one cannot be certain of this. In any event, there were specific indications for each of the therapeutic measures instituted and a fortunate recovery from an illness that ordinarily has an 80 to 90 per cent mortality was obtained.

Our 2 other patients had localized areas of suppurative gastritis. In Case 2 there was a pyloric stenosis due to an obstructing duodenal ulcer; a biopsy specimen of a distant area of localized gastritis was obtained and a gastro-enterostomy was performed for relief of the obstruction. There was no visible or palpable relation between the ulcer and the suppurative process. In Case 3 the patient had chronic pyloric obstruction which was caused by a localized gastric phlegmon. Pyloroplasty resulted in relief of the obstruction. As the patient recovered and was well 8 years later it must be assumed that this was a low grade inflammatory process that subsided spontaneously after relief of pyloric stenosis. An ulcer of the stomach or duodenum was not demonstrable then or later.

It is important for the clinician to be cognizant of these two forms of suppurative gastritis in order that the diagnosis may be established more often and, accordingly, more knowledge obtained of the pathogenesis of a disease which though apparently rare may at the same time be closely related to a more common disease, peptic ulcer.

This small report again emphasizes the dependence of the surgeon on the pathologist, and acknowledge our

deep gratitude to Dr. S. B. Wellbach and Dr. Daniel Lye. Their notation of vitamin C deficiency in Case 1, from study of the histological preparation, may have been the determining factor in the recovery of this patient.

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OBSERVATIONS ON ACUTE APPENDICITIS

A Series of 635 Cases

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NUMEROUS papers on appendicitis have been appearing in the recent literature. The value of these papers lies in the fact that the mortality of this disease is still out of keeping with the improvement in diagnosis and in operative technique. It is in the hope that we shall be able to add further evidence as to some of the factors causing this disparity that we offer this paper.

This analysis of appendicitis is based on 635 consecutive cases in which patients were operated upon at the Beth Israel Hospital. Both private and ward cases are included and the operations were performed during the period between January 1, 1931, and July 1, 1936. The cases were in no way selected, they include every case in which operation was performed during the period mentioned and in which the microscopic pathological report was acute appendicitis. Neither cases of chronic appendicitis nor those in which the appendix was removed incidentally during a laparotomy for some other disease have been included. Practically every member of the surgical staff of the hospital is represented in the series and in addition some twenty house officers performed many of the operations under the supervision of a member of the attending surgical staff.

The cases were divided into four main categories according to their macroscopic pathology, namely, acute appendicitis, acute appendicitis with local peritonitis, gangrenous appendicitis, and appendiceal abscess. The group of gangrenous appendicitis cases was further subdivided into perforated and non-perforated cases.

To make easier a comparison of this report with others in the literature, we should like to define the first two groups, the latter two groups are self-explanatory. The classification of acute appendicitis we limited to those cases in which there was no macroscopic evidence of peritoneal involvement of the appendix other than a roughening of its serosa, the group of cases of acute appendicitis with local peritonitis to those in which there was thick fibrinous exudate covering

the appendix or the surrounding viscera, or fluid in the peritoneal cavity.

A tabulation of our series is shown in Table I.

TABLE I—CLASSIFICATION OF CASES

	Cases
I Acute appendicitis	191
II Acute appendicitis with local peritonitis	200
III Gangrenous appendicitis	
A Non perforated	101
B Perforated	52
IV Appendiceal abscess	91
Total	635

HISTORY

Some factors in the history were studied in order to evaluate their importance. In 194 patients (30.7 per cent of the total series), there was a history of one or more previous attacks. From these figures it can be seen that the incidence of acute appendicitis is much higher than would be indicated by vital statistics, inasmuch as many of them do not come to operation until they have had one or more previous attacks. In view of the high incidence of previous attacks in our series, it offers a diagnostic aid.

Chronic constipation as a predisposing factor is relatively unimportant, occurring in only 106 cases (16.7 per cent). Dietary indiscretion played little or no part in this series as it was present in less than 10 patients.

Nausea and vomiting were very frequent symptoms in the immediate history, nausea occurring in 458 cases (72.8 per cent) and vomiting in 378 cases (60.1 per cent). Pain was an invariable symptom in our series, the location varying, but most often was confined to the right lower quadrant of the abdomen during the course of the disease.

Chills were present in 41 cases of this series and it was noted that although these cases were distributed more or less equally throughout the various groups here tabulated, the mortality rate in those patients who had chills in the history was 7.3 per cent in contradistinction to the average mortality for the whole series of 2.2 per cent. The chills as a rule occurred at the onset of the

illness. A more advanced pathology was found in these cases, for 35 of the 41 cases with chills were in groups III and IV. Chills in the history therefore warrant a more guarded prognosis.

Diarrhea and frequency of urination were found to be relatively infrequent, the former occurring in 12 patients and the latter in only 10.

SIGNS AND LABORATORY DATA

Abdominal tenderness was a constant sign and preponderantly situated in the right lower half of the abdomen. The localization of the point of tenderness was, however, no indication of the exact position of the appendix.

A study of the pulse rate demonstrated a definite relationship to the severity of the pathological process, a pulse rate over 120 being present in a much larger proportion of the cases with more advanced pathology.

In cases of acute appendicitis, only 6 per cent had a pulse rate above 120. In those with acute appendicitis with local peritonitis the pulse rate was above 120 in 10 per cent, whereas in cases of gangrene of the appendix without perforation 16 per cent of the cases had a pulse rate above 120. Abscess cases showed a pulse rate above 120 in 21 per cent, while gangrene with perforation had the greatest percentage, namely 30 per cent.

Blood counts were done in 474 patients and were found to be a very reliable indication of the severity of the pathological process. Only 46 cases of the 474 had a white blood count below 9,000 cells per cubic millimeter. A blood count over 15,000 was found in 50 per cent of the cases of acute appendicitis, in 60 per cent of those with local peritonitis, in 7 per cent of those with gangrene whether perforated or not, and in 53 per cent of the cases of appendiceal abscess. In view of the constancy of the elevation of the white blood count in the more severe cases of acute appendicitis, we feel that even if the diagnosis is apparently obvious, a blood count should be done to aid in diagnosis and prognosis.

FACTORS IN INCIDENCE

The age distribution of our series was similar to that reported in the literature. Our oldest patient was 84 years, and our youngest 18 months. The largest number of cases occurred in early adult life and during adolescence, 74 per cent of our cases were less than 30 years of age.

The distribution as far as sex was concerned was 385 males and 250 females in the approximate ratio of 3 males to 2 females.

An interesting finding was the seasonal incidence of acute appendicitis. During the 6 month

period from March to September twice as many cases of acute appendicitis occurred as during the other 6 months. Speculation on the above finding might lead one to suspect that there may be some relationship between the occurrence of acute appendicitis and the increased number of intestinal disorders during these months. From such a brief study it is impossible to arrive at a definite conclusion.

FACTORS IN PATHOLOGY

Our cases were studied from the standpoint of the relationship between the pathological process found at operation and the duration of the preceding symptoms. In general, it may be said that with a longer history the pathological findings were more advanced. Where the history was less than 12 hours, only 9 per cent of the cases were in groups III and IV. A history of 12 to 24 hours showed 28 per cent of the cases in these two groups, and 46 per cent of the cases with a 24 to 36 hour history fell into these groups. Further, a 36 to 48 hour history showed 50 per cent, and a 48 to 72 hour history 70 per cent of all cases belonged to groups III and IV. A history of 72 to 96 hours presented 70 per cent of the cases in these groups, and finally a history of more than 96 hours placed 83 per cent of all the cases into the two groups mentioned.

A short history, however, does not preclude the presence of an advanced pathological process as evidenced in 16 cases of gangrenous appendicitis with perforation in which the history was of less than 24 hours' duration.

Cathartics as a factor in increasing the mortality rate in acute appendicitis has been repeatedly stressed. In an attempt to evaluate the influence of cathartics in this disease, we studied the relationship between cathartics and the type of pathology found at operation.

Since all the deaths in our series occurred in cases of gangrene of the appendix (group III) and in the appendiceal abscess cases (group IV) a comparison was made between the percentage of cases falling into these two groups on the basis of taking cathartics. Information on this point was available in 615 cases. In 430 cases in which no cathartics were taken, 31.5 per cent of the cases belonged to groups III and IV. In 195 cases in which cathartics were taken, 49.4 per cent belonged to groups III and IV. In general, in this series, a definite swing to a more serious type of pathology was noted with the taking of cathartics. Appendiceal abscess, for instance, occurred twice as often in our series in those who had taken cathartics as against those who had not.

FACTORS IN MORTALITY

There were some outstanding factors that were noted in studying the mortalities in our series. Foremost was diabetes. Although there were only 10 patients with accompanying diabetes, it is significant that 3 of the deaths were in this group, representing a mortality of 30 per cent. These patients were in an older age group than the average for the whole series, but when compared to a similar age group without diabetes, it was found that the mortality was $7\frac{1}{2}$ times as great. The pathological condition found at operation in all cases with one exception was very advanced. In view of these facts, cases of acute appendicitis accompanied by diabetes offer a poor prognosis and therefore operation should be carried out without delay.

In the series were 17 patients who gave a history of cardiac decompensation at some time in the past. There was one death in the group, but this patient also had diabetes. This observation confirms the general impression that heart disease *per se* is no contra-indication to urgent surgery in acute appendicitis. Compensated cardiac disease, in our experience, does not alter the prognosis in any way.

We feel that the duration of the disease before operation and the taking of cathartics represent the two major factors in mortality. A study of the 15 deaths in this series from this standpoint bears out this contention.

The average duration of the disease before operation in the 15 mortalities was 5.4 days. Twelve of these 15 cases had a history of symptoms varying from 3 to 14 days.

A history concerning the taking of cathartics was not obtained from 2 patients, but of the 13 others, 8 had taken cathartics. This confirms the impression gained from our series and substantiates the extreme danger of catharsis in acute appendicitis.

TECHNICAL FACTORS IN TREATMENT

In view of the tendency of surgeons to avoid drainage in cases of acute appendicitis, we studied our series with this in mind.

Drainage was used in only 10 of 191 cases of acute appendicitis, in 33 of 200 cases of acute appendicitis with local peritonitis, in 45 of 103 cases of gangrenous appendicitis without perforation, in 48 of 52 cases of gangrene with perforation, and in 84 of 91 cases with appendiceal abscesses.

Some explanation as to the omission of drainage in the cases of gangrenous appendicitis with perforation and abscess is necessary. The 4 cases of perforation of the appendix in which no drain-

age was used were all cases in which the perforation was occluded by omentum or by adjacent intestine, and in the opinion of the surgeon there was no reason for drainage. The 7 cases of abscess which were not drained were all mesenteric abscesses removed *in toto* together with the appendix without opening into the abscess and were therefore judged to be relatively clean cases.

Drainage was also studied as to its effect on the length of hospitalization. In 180 cases of acute appendicitis, with no drainage, the average stay was 12.2 days, in 10 cases of similar pathology in which drainage was used, the average stay was 14.4 days. In 167 cases of acute appendicitis with local peritonitis in which drainage was not used, the average stay was 13.8 days, whereas 33 patients with similar pathology in whom drainage was used, remained in the hospital 17.2 days. Fifty-eight patients with non-perforated gangrenous appendicitis in whom drainage was not used had an average hospital stay of 16.7 days, 42 patients in this same group in whom drainage was used had an average stay of 15.6 days.

In the next two groups, namely those in which perforation had occurred and those that presented appendiceal abscess, no such comparison was necessary because very few cases in these groups were undrained, in conformity with general opinion.

These figures show conclusively that drainage prolonged the hospital stay in the first two groups. In our series an average increase of 3 days in the period of convalescence occurred when drainage was used. In the group of non-perforated gangrenous appendicitis, the average hospital stay of the drained cases was apparently shorter than that of the undrained cases. This can be explained by the fact that the 2 mortalities in this group occurred in 2 drained cases and death occurred on the second and fourth days. Although the 2 patients who died had drainage, the number is insufficient to draw general conclusions. An additional fact to be considered is that the patients with drainage all left the hospital with some degree of discharge from their wounds and on this score undoubtedly had a longer convalescence than those not having drainage. Generally, with the passing of time, fewer patients in the group of non-perforated gangrenous appendicitis are being drained. Drainage is now practically limited to patients with perforation or abscess.

As a point of interest, the Battle-Kammerer incision was used in all but 1 case.

There were two methods of treatment of the appendiceal stump, namely, non-peritonealiza-

tion of the stump and peritonealization by means of a cuff except in 10 cases in which a pursestring suture was used. We were unable to discover any significant changes in the postoperative course that could be attributed to the variations in the treatment of the appendical stump.

COMPLICATIONS

A study was made of the various complications that arose in relation to the pathology found in the appendix in order to see in which type of case the various complications were more frequent. The following paragraphs will be devoted to an enumeration of these complications in relation to pathological headings previously used in this paper.

The first complication studied was infection of the wound. The criterion of an infected wound was the presence of bacteria in the fluid obtained from the operative wound. Wound infections were directly proportional to the seriousness of the infection in our series, occurring in 5.2 per cent in group I, in 9.5 per cent in group II, in 14 per cent in type IIIA, in 28.8 per cent in group IIIB, and in 15.5 per cent in group IV.

Of course patients in whom drainage was instituted would be more likely to develop an infection of the wound due to the possibility of organisms being disseminated from the drainage tract into the various abdominal layers. In spite of this, however, the relatively higher percentage of infections speaks for the probability of the wound being infected by the operator's hands or by instruments at the time of operation. We feel that all the layers of the abdominal wall should be protected during the entire operation in order to minimize contamination of the wound.

Postoperative ileus occurred in 9 cases which represents 1.4 per cent of the total series. Of these 9 patients, 3 died. Fourteen patients developed a postoperative abscess which required subsequent drainage. Of this group 3 were in patients with acute appendicitis, 4 in patients with acute appendicitis with local peritonitis, and 7 were in patients who had an abscess at the time of operation. Pyelophlebitis and multiple liver abscesses occurred in 4 patients, all of whom died. Two were in patients with gangrene and perforation of the appendix, and the others were in cases of appendiceal abscess. There was one case of subphrenic abscess in a patient with a perforated gangrenous appendix. Embolization of the pulmonary artery occurred twice but was not fatal. Atelectasis occurred in 2 cases. Phlebitis as a complication occurred 5 times. Pneumonia occurred in 7 patients. One of these patients developed an empyema of the chest

that had to be drained. Hemorrhage from the wound occurred in 3 patients and in one was a contributory cause of death. Evisceration occurred three times without fatality. Fecal fistulas occurred in 4 cases of abscess but all closed spontaneously.

DISCUSSION OF MORTALITIES

Although the mortality rate for the whole series is 2 per cent and compares favorably with other reports, we feel that an analysis of the deaths on the basis of the pathological groupings used in this paper is worth while and would tend to dispel the optimism that might be created by this low mortality (Table II).

TABLE II.—MORTALITY ACCORDING TO PATHOLOGICAL GROUPS

	Cases	Deaths	Mortality per cent
Acute appendicitis	9		
Acute appendicitis with local peritonitis	200		
Gangrenous appendicitis			
Non perforated	10		
Perforated	52	7	13.4
Appendiceal abscess	9	6	66.6

We are of the opinion that the incorporation of a separate group of cases of spreading peritonitis would offer a better classification of acute appendicitis.

To determine accurately the cases that could belong to such a group would be difficult, because such a diagnosis depends too much upon the personal impression of the operating surgeon. It is not unusual to see cases in which the interpretation at the time of operation was that of a severe spreading peritonitis. In many of these cases, the postoperative recovery was so rapid and uneventful that the interpretation at operation appeared doubtful. On the other hand, the experience of finding a relatively mild peritonitis at operation with ensuing postoperative reaction that was more befitting a case of spreading peritonitis, was frequent enough.

Those patients who presented free pus in the peritoneal cavity undoubtedly included all the cases of spreading peritonitis. Computing our mortality on the basis of this group alone, we arrived at the following: in the group of non-perforated gangrenous appendicitis, there were 9 cases with 2 deaths, a mortality of 22 per cent; in the group of perforation and gangrene of the appendix, there were 25 cases with 7 deaths, a mortality rate of 28 per cent, and in the group of appendiceal abscess, there were 19 cases with 6 deaths, a mortality rate of 31.6 per cent.

SUMMARY AND CONCLUSIONS

A series of 635 cases of acute appendicitis operated upon during a 5 year period was discussed from the viewpoint of etiology and factors in mortality and pathology. The total mortality for the whole series of cases was 15, or 2.2 per cent.

This represents an unselected group of cases, the operations being performed by about 70 different surgeons, including 20 house surgeons.

The technique must be as meticulous as in any major abdominal operation. None of the mortalities in this series could be attributed to the house officers as the patients upon whom they operated were all selected and a member of the attending staff always assisted at operation.

Since the object of this paper has been to analyze the mortality in acute appendicitis, we have discussed those factors which have contributed to mortality and have found the important factors to be the duration of the disease and the use of cathartics. Diabetes was also found to be a serious complication.

The element of time cannot be overstressed, for the profession and the public should be made to realize the seriousness of waiting in these cases.

In a few patients the lesions progressed very rapidly, but these were the exception.

From our study we can definitely assert that cathartics increase the severity of the disease. The fact that the taking of cathartics will increase the risk of a fatal outcome in acute appendicitis should be more forcefully brought to the attention of the public.

There should be no temporizing in cases suspected of being acute appendicitis when diabetes is a complicating factor because the pathological process advances with great rapidity in such cases.

The group that produced the highest mortality in the series was that of gangrenous appendicitis with perforation. This is in complete agreement with the experience of others as reported in the literature upon this subject. Early operation and the omission of cathartics will prevent the progress of the disease to the state of gangrene or perforation and thus the mortality will be lowered. The problem of treatment in such cases, however, is still far from solved. Since it is a general rule in our hospital to operate immediately when the diagnosis of acute appendicitis has been established, we are not in a position to evaluate other methods of treatment.

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SOME EXPERIMENTAL AND CLINICAL ASPECTS OF THE USE OF HEPARIN

THE recent demonstration by the Toronto group that heparin is not only an anticoagulant but is also a preventive of thrombosis and that in purified form it has been administered to living animals without injurious reaction has brought this drug to a position of great practical clinical importance.

The first experiments to investigate the effect of heparin on thrombosis were done by producing thrombosis in peripheral veins in control animals. By means of heparin this thrombosis could be prevented in a high percentage of cases. Arterial anastomosis was successful in a much higher percentage when heparin was used. Venous grafts, which invariably became occluded when heparin was not used, remained patent when successful experiments were completed. This is the first event in which venous grafts could be used successfully. Shiono's experiment with an

extracorporeal loop also provided further evidence of the effect of heparin in preventing thrombosis, as these tubes would remain clear so long as the clotting time was kept well elevated with heparin. Cardiac valves were placed experimentally in animals' hearts quite successfully when heparin was used. Artificial emboli which caused severe reactions in the walls of the containing vessels, could be removed successfully and the vessels kept patent when heparin was used. In numerous experiments on the portal system heparin was shown to be effective in preventing thrombosis. Organs were transplanted and the result was successful in a high percentage of cases when the drug was used. Best and Solandt demonstrated that coronary arteries which became occluded after injecting sclerosing solutions could be kept patent with the use of heparin. The mural thrombus, which forms rapidly on the infarcted area, was also prevented when heparin was given. These experiments by Murray combined with the evidence obtained from many clinical tests proved satisfactorily that heparin would prevent thromboses.

Multiple tests were also made to test whether or not heparin was toxic. As this substance went through its various stages of purification by Best, Charles, and Scott, its toxic properties gradually disappeared. When these workers finally succeeded in producing the crystalline barium salt of heparin, the toxic properties disappeared completely in animals.

With heparin in a purified form, which had been found to be non-toxic in animals and which had been proved to prevent thrombosis as well as clotting, it seemed that a

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able time had arrived to make a clinical test. Earlier clinical tests by other workers with less purified heparin revealed the fact that the drug was fairly toxic, but we hoped to find that this more purified form would be free from these ill effects. In a clinical test by Murray, MacKenzie, and Wilkinson, in more than four hundred patients there were no sensations from its administration and there were no thermal or other untoward reactions. Clotting times varying from twelve to thirty minutes were obtained regularly with no ill effects. Recently a slight modification of the technique of producing heparin had apparently changed the substance somewhat, as there were febrile reactions in about half the patients receiving it. More recently these toxic effects have again been eliminated. Several patients have received heparin on more than one occasion and there has been no anaphylaxis in any of them.

Heparin is given by a continuous drip through a steel needle lying in a superficial vein. In these four hundred patients, even though the needle was left at the same site in the vein for periods up to two weeks, there has been no thrombosis in these veins. This in itself is strong proof of the effectiveness of heparin in preventing thrombosis in human beings. Crawford and Jorpes have obtained good results by intermittent intravenous injections.

With the use of heparin, twelve clinical embolectomies have been done. When the obstruction of the vessels was relieved, all of these vessels remained patent and the clinical results were entirely satisfactory. This is in great contrast with former embolectomies and with other palliative methods of treatment which were followed by gangrene in a high percentage of cases.

As pulmonary embolism is a common post-operative complication and as it has been

proved that heparin would prevent thrombosis, it was used in a group of cases after operation. There were more than three hundred in this group and while the number is too small from which to draw final conclusions, it is an interesting observation that none of the patients developed thrombosis or embolism even though many of them had undergone the types of major surgical operations which are prone to develop thrombosis and embolism. Hematomas occurred in five cases but none of these were of serious proportions and all the patients recovered. As it has been demonstrated experimentally that heparin will not dissolve or loosen a clot, it is obvious that in such cases vessels were left, which should have been ligatured. In ordinary good surgery when the large and medium sized vessels are tied off, heparin will not cause a hematoma. The bleeding from a capillary bed is not prolonged by heparin and the ordinary clotting processes act on these surfaces and are not changed by the presence of the moderately prolonged clotting times which are used in these clinical cases.

As thrombosis is at least one factor in thrombophlebitis, a group of seventy-two patients with this disease were treated with heparin. The improvement in the clinical course was impressive. The pain, temperature, and edema subsided much more rapidly than in a control group of cases. On the average, these patients were treated for one week to ten days, at the end of which time they were out of bed exercising actively and able to be discharged from the hospital. In these cases the clotting time is elevated to about three times the normal level, varying between fifteen and twenty minutes. Future work may show that some other level may be the optimum but to date this has been a quite satisfactory level.

In twenty-six of these patients pulmonary embolism had occurred. Many of these had massive embolisms giving the clinical picture of a patient in *extremis* from this disease. Before treatment of these patients was undertaken the possibility of further embolisms was considered because a venous system in which active thrombosis is taking place almost certainly contains other thrombi which may become detached at any moment. While the group of cases is too small from which to draw conclusions it is interesting that none of these twenty-six patients died of embolism. One, or possibly two might have had further small embolisms within the first few hours after treatment was begun but this was not proved. The remainder of the patients made a rapid recovery with early marked relief of the respiratory and cardiac distress as well as relief of symptoms from the peripheral thrombophlebitis present in most of them. It is interesting to note that other workers, Olsen and Charnoff have had similar experience with this type of case. While there is insufficient evidence so far to advocate general use of heparin for this disease it is worth further investigation, especially as palliative methods only apart from operation are available otherwise.

The high mortality rate from progressive thrombosis in cases of mesenteric thrombosis involving a sufficient length of bowel to require surgical resection seemed to present a challenge to the effectiveness of heparin in the portal system. It was with great satisfaction that Murray and MacKenzie observed the recovery of the first four cases of this disease in whom from two to seven feet of bowel had been resected followed by treatment with heparin. These patients are alive and well today for periods varying from nine to eighteen months. Two other patients who

were treated with heparin died one of bronchopneumonia and the other of peritonitis. Postmortem examination in both of these showed that there was no extension of thrombosis and that the intestine was viable. This was one of the most important and critical clinical tests of the effectiveness of heparin.

In a few cases of splenectomy for familial jaundice and other lesions in which portal thrombosis causes a high mortality heparin has also been used successfully and no thrombosis has occurred.

In coronary and cerebral thrombosis, there is a possibility that heparin might be of value in preventing the extension of the disease. There have not been enough of these patients treated to know what effect heparin might have. In vegetative endocarditis when infection and thrombosis are combined there is the possibility that heparin might control the thrombosis and combined with a blood sterilizing drug this disease might be cured. The number of patients treated in Toronto is too small to draw conclusions and this as most other stages of this work must still be considered to be in the experimental stage even though encouraging results have been obtained elsewhere. In cavernous and lateral sinus thrombosis as well as in osteomyelitis when septic emboli are discharged heparin has appeared to be of value. The number of patients treated is too small to draw conclusions.

In blood transfusions heparin has been used quite satisfactorily either by adding the drug to the blood as it is withdrawn or by giving the donor a sufficiently large dose to change the clotting time of his blood. The results have been satisfactory with both methods.

It is interesting that in one clinical case Murray placed the external jugular vein as a graft, in a gap in the popliteal artery and with

heparin treatment the graft remained patent and functioned as part of the arterial system. Several end-to-end anastomoses of main arterial trunks have been done successfully in patients, and these have remained patent with the use of heparin. This opens the way for a wide application of this principle in many injuries and diseases of the vascular tree, which were formerly treated by ligation with disastrous results in some. While this work is still in the experimental stage, evidence is rapidly accumulating to show that heparin is of great value in dealing with injuries, thrombosis, and diseases involving blood vessels. It probably has opened a new vista in the treatment of these lesions.

D. W. GORDON MURRAY

TREATMENT OF CHOLEMIC BLEEDING

COMPETENT authorities have said that further improvements in the effectiveness of surgical procedures and reduction in the surgical mortality would be brought about chiefly by studies on the pathological physiology of diseases requiring surgical treatment. This type of work has been prosecuted with special vigor in recent years and in many fields notable improvements in surgical results have been accomplished. One of the most interesting advances in this direction during the past few years has been made concerning the enigmatic problem of cholemic bleeding.

During the past three years several groups of investigators in this country^{1, 2} and abroad³ independently have demonstrated that in most cases of jaundice or of primary hepatic injury a deficiency of prothrombin exists in the circulating blood which can be corrected

by the administration of concentrates containing vitamin K. Several of these authors have pointed out carefully that cases of severe hepatic damage are encountered occasionally in which there is no response to treatment with vitamin K and that treatment in general is accompanied by many serious pitfalls which can be overcome only by alertness and basic physiological knowledge of the whole problem.

Several investigators have noted that in the course of treatment of patients with hypoprothrombinemia, vitamin K frequently cannot be taken by mouth. The products formerly available were not suitable for effective parenteral administration and a more pure product obviously was needed to supply adequate material for parenteral administration and to eliminate those unknown substances, other than vitamin K, which were being given when concentrates of alfalfa were employed.

The clinical application of recent knowledge concerning vitamin K has been dramatic, but equally so have been the results of study of the chemistry of vitamin K. During the past year vitamin K₁ has been isolated in pure form from alfalfa and synthesis has proved it to be 2-methyl-3-phytyl-1, 4-naphthoquinone.⁴ A vitamin K₂ also exists and can be extracted from fish meal but its structure as yet has not been determined. Several synthetic compounds, possessing high antihemorrhagic activity, also have been discovered and of these compounds, phthiocol and 1, 4-dehydroxy-2-methyl-3-naphthaldehyde administered intravenously and 2-methyl-1, 4-naphthoquinone administered by mouth have proved to be useful clinically. Of these compounds 2-methyl-1, 4-naphthoquinone possesses an antihemorrhagic activity nearly equal to that of pure vitamin K₁ and for patients with hypoprothrombinemia this compound is effective in daily doses as small as 1 or 2 milligrams when

¹WARNER, E. D., BRINKHOUT, K. M. and SMITH, H. P. *Proc. Soc. Exper. Biol. & Med.* 1938 37 628-630.

²BUTT, H. R., SNELL, A. M. and OSTERBERG, A. E. *Proc. Staff Meet. Mayo Clin.* 1938 13 74-30.

³DAM, HENRIK and GLAVIND, JOHANNES. *Lancet* 1938 1 720-721.

⁴BINKLEY, S. B., MACCORQUODALE, D. W., TRAYER, S. A. and DOISEY, E. A. *J. Biol. Chem.* 1939 130 219-235.

administered by mouth together with animal bile salts. This product is not soluble in water and further studies will determine whether or not it can be used parenterally. The compound is simple, fairly stable and possesses a high antihemorrhagic activity. Because of these qualities, adoption of this compound as a standard for vitamin K has been suggested.

The various synthetic products, no doubt will soon replace the more crude but effective concentrates of vitamin K now used and the availability of standardized materials which can be administered orally or intravenously

give hope that surgical mortality attributed to cholemic bleeding itself will be relegated to the surgery of the past. It is perhaps well to remember that the discovery of thyroxin gave hope in the past that the cruder thyroid extract would soon be replaced but time has proved otherwise. It may be wise to continue the use of the old but tried concentrates of vitamin K which are known to be effective and without untoward reactions until the newer synthetic products have received wider clinical and experimental investigation.

HUGH R. BURR

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE latest volume containing the proceedings of the New York meeting in 1937 of the *Association for Research in Nervous and Mental Disease*¹ is the eighteenth consecutive volume in an imposing group of research publications. This entire series has been meritorious for its continuous presentation of new and reliable data of fundamental importance, and the present volume is no exception to this precedent.

A division of the material into three sections, namely, anatomy and physiology, pathology, and clinical contributions, makes natural the correlation of newer morphological concepts of the circulation of the central nervous system to disease states, and the application of constantly new methods of treatment. Particularly provocative are the questions which Bronk, Gerard, and others have raised concerning the effect of anoxia, oxygen availability, brain metabolism, in fact, the alterations of cerebral circulation. In a discussion of the hematoencephalic barrier, i.e., the blood brain barrier, King has reviewed the concept of "endothelial barrier" as opposed to the concept of "lack of affinity," and on the basis of his vital staining experiments he accepts the latter theory as the one responsible for the failure of the brain to stain with trypan blue. That is, the impermeability of the endothelium of the cerebral capillaries is not the cause of the failure of the brain to stain, rather, the failure of the subjacent glial tissue in the brain to attract the dye, as opposed to the affinity between stain and connective tissue in the other vascular beds of the body, accounts for the cerebral blood barrier. His paper opens up several lanes of thought even if it does lack complete finality of proof.

The book contains an outstanding chapter by Soma Weiss on the regulation and disturbance of the cerebral circulation through extracerebral mechanisms in which there is a comprehensive review and discussion of the rôle of the carotid sinus, and of syncope, circulatory failure, shock, and cerebral anoxia caused by factors other than the carotid sinus in the production of many well known clinical syndromes related to abnormal cerebral circulation. This chapter is replete with facts and suggestions of clinical application and importance.

This eighteenth volume does not, of course, settle all questions arising from our lack of knowledge of the nature of the cerebral and spinal circulation and the pathological entities attendant thereon. But it does represent a convergence of theory, experiment, and practice, it is an exposition of much new and

fundamental knowledge of the morphology and physiology of the vascular tree in the central nervous system, and it is, above all, the result of co-ordinated research effort.

JOHN MARTIN

THE authors have completely revised the third edition of *Lehrbuch der Roentgendiagnostik*². Nearly every specialty has developed a massive text in which one may find boiled down to the briefest space compatible with practical value the sum total of knowledge relating to its particular field of medicine. Here we have such a fund of knowledge concerning radiological diagnosis. The text does not include any discussion on roentgen therapy, but the preliminary sections present a very detailed exposition of the physical laws relating to x-rays, fluoroscopic screens and x-ray films, and the general principles of roentgenography. For details of radiographic technique, the reader is referred to the appropriate books of technical instruction.

The two volumes represent the highest mark yet attained in the production of roentgen diagnostic texts. The first volume deals entirely with bones and joints, the second with internal medicine. When it is realized that nearly 1,000 pages are devoted to the radiology of bones and joints, the skull and its contents, the facial accessory sinuses, and the teeth, he will appreciate the tremendous labor involved in the production of the first volume. The text is unusually well done, only here and there are seen evidences of haste. The illustrations are as nearly perfect as could be expected.

The second volume deals with the thorax and its contents, followed by the digestive tube, the biliary tract, the urinary tract, and roentgen considerations of obstetrical and gynecological diagnosis. The 1,200 pages of the second volume match the first in evidence of great care in revision, so that all the new material on mucosal relief, kymography, tomography, etc., is included.

The authors and the publisher merit our gratitude for such a splendid text.

JAMES T. CASE

THE booklet of 57 pages from the *Privy Council Medical Research Council*³ is based on a statistical study of the mortality of appendicitis in England and in other countries. Such a report should be of particular concern to those who are interested in the study of appendicitis.

Many factors are investigated, such as relation of the mortality of appendicitis to age, sex, marital

¹LEHRBUCH DER ROENTGENDIAGNOSTIK. By H. R. Schinz, W. Baensch and E. Friedl. 4th enl. rev. ed. Vol. 1—Skelett. Vol. 2—Innere Organe. Leipzig: Georg Thieme 1939.

²PRIVY COUNCIL MEDICAL RESEARCH COUNCIL. Special Report Series No. 233. Appendicitis: A Statistical Study. By Matthew Young and W. T. Russell. London: His Majesty's Stationery Office 1939.

³ASSOCIATION FOR RESEARCH IN NERVOUS AND MENTAL DISEASE. Vol. 18 of a Series of Research Publications. The Circulation of the Brain and Spinal Cord: A Symposium on Blood Supply. The Proceedings of the Association, New York December 27 and 28 1937. Baltimore: The Williams & Wilkins Co. 1938.

state, seasonal incidence, and the problem of diet. Regional distribution and the relation of appendicitis to urbanization are also studied. There is no great variation between the mortality rates of England and America. Further, decrease is shown in the case fatality of appendicitis despite an apparent increase in the incidence of the disease. This report points out the great increase in the mortality of appendicitis in the extremes of life while in the middle decades there is a decrease. The mortality rate for the higher social class is found to be about two and one half times greater than for the poorer social class. Although at the first reading this report seems mass of statistical data, a more careful study discloses many interesting points concerning the mortality of appendicitis. HARVEY S. ALLEN.

THE phyletic variations of the brachial plexus is discussed by Wilfred Harris in his unique monograph entitled *The Morphology of the Brachial Plexus*. The book represents the conclusions of almost 40 years of meticulous work on a wide variety of animals, some of which because of their rarity had been obtained for study with great difficulty. The material presented is based on the author's dissection of the brachial plexus in 158 cases (on both sides in some specimens) divided as follows: 30 human beings, 6 anthropoid apes, 37 monkeys, and 85 other animals and birds, including all classes above fishes from amphibia and reptiles to primates. The arrangement of the dorsal and ventral divisions of the nerves with their branches, running in consistent patterns to the dorsal and ventral components of the limb buds, led the author to believe that it is highly probable that the neuromuscular supply in different animals is most useful, if not invariable, guide to muscular and nervous homologies.

The plexus is simplest in the anuran with only the 3 upper spinal nerves contributing. It is most complex in the primates. There is a brief discussion of the Foerster theory that muscle is to be regarded as the end organ of a nerve, and a brief treatise is added on the gross structure of the pectoral muscle in mammals. The book is nicely illustrated by colored plates of the various types of plexuses, and each class of animals is treated by a separate and complete description. This monograph offers a ready and concise means for comparison of the plexus in the various phyla above the frog, and should prove to be of special use and interest to comparative anatomists and teachers of anatomy. JOHN MARTIN.

FROM the preface one learns that *A Textbook of Pathological Gynecology*, consisting of 575 pages and illustrated with 75 engravings, is an intrud-

QUINTO MEDICAL PUBLICATIONS. THE MORPHOLOGY OF THE BRACHIAL PLEXUS, WITH A NOTE ON THE PECTORAL MUSCLE AND ITS TENDON. BY WILFRED HARRIS, M.D. New York and London. Oxford University Press, 1930.
ILLUSTRATED BY PHILIPPO GIOVANNI. BY J. THOMAS H. BARR, M.D. and M. COHEN, M.D. Philadelphia. Lea Brothers, 1930.

sion to the subject. It is intended to give students an insight into gynecological pathology and to assist in correlating clinical syndromes with the gross and microscopic pathology of diseases peculiar to women.

The contents have been arranged according to anatomical location rather than similarity of diseases. There are 3 sections, namely pathology of the vulva, pathology of the vulvovaginal glands, pathology of the vagina, pathology of the cervix, anterior pituitary gonadotropic hormone, the ovarian hormones, menstruation and its disorders, gynecological disorders of early pregnancy, pathology of the endometrium, pathology of the myometrium, miscellaneous terine disorders, pathology of the fallopian tubes, and pathology of the ovary. The sections on pathology consist of a few pertinent statements about the clinical signs and symptoms, a description of gross and microscopic pathology and a few lines on treatment of each lesion considered. Most of the conditions are illustrated by drawings or photographs of the gross specimens and photomicrographs. The sections on endocrinology are the outstanding features of this book. The subject matter is presented in a delightful style and it is conclusive.

Those of us who conduct courses in gynecological pathology are sorely in need of a textbook for students. Possibly it would be appropriate to offer some suggestions which might broaden the appeal of Witherspoon's book. The frequency of errors in proof-reading is disconcerting. The original illustrations of gross specimens are photographs; most of them lack clarity and unfortunately none is reproduced in color. The quality of the photomicrographs is better but many of them should be replaced with more convincing illustrations. There is a lack of balance; 75 pages are devoted to pathology of the ovary and 20 of these pages are consumed by the rare Brenner and spermal endocrinal tumors. This exceeds the space devoted to the frequent and highly important cystadenomas and carcinomas. In fact, it almost equals the space allotted to cancer of the cervix.

Under erosion of the cervix one reads, "Whatever might be written, this text would only be a personal point of view and opposing evidence could be readily advanced to contradict the stated hypothesis. Whenever such debatable and unsettled problems are encountered, the policy followed in this book is to make no dogmatic statement but to let the reader judiciously choose his own side of the question. Such a tilt is commendable but the sections on endometriomas and terine fibromyomas reveal marked deviation from this policy.

GEORGE H. GARDNER

THE second edition of *Textbook of General Surgery* by Warren H. Cole, of Chicago, and Robert E. Elman, of St. Louis, has been published.

TEXTBOOK OF GENERAL SURGERY. BY WARREN H. COLE, M.D. and ROBERT E. ELMAN, M.D. 10th ed. New York and London. Appleton-Century Co. Inc. 1930.

recently by the D Appleton-Century Company of New York. The original edition was the outgrowth of a course of lectures given during a period of 8 years while the authors were at Washington University Medical School and, therefore, was especially designed for medical students.

The subject matter has been presented from the physiological point of view with emphasis on surgical pathology and the general principles underlying surgical procedures. Great detail in the technique of operations has been omitted purposely in order that the more important things might be covered within the scope of a single volume. The second edition has brought to the student and practitioner of surgery a consideration of the very latest advances in a field where rapid progress is being made, and to this the editors themselves have richly contributed.

EDWIN M. MILLER

THE eleventh edition of *Pye's Surgical Handicraft*¹ has been recast and prepared by Hamilton Bailey. The first volume appeared 54 years ago. This volume corresponds in many ways to what is known in this country as "minor surgery," but in England it is known as a "manual of surgical manipulations, minor surgery, and other matters connected with the work of house surgeons and of surgical dressers."

Twenty-eight contributors help to make up this volume which contains chapters on practically every specialty in medicine and surgery, as well as briefer chapters by the nursing, legal, and dental professions. Each chapter is concise, well written, but in many instances rather superficial. Practically everything that might confront an interne or resident during his hospital stay is covered in this volume of 475 pages.

All in all, I would not hesitate to recommend the book to the interne beginning his hospital training, I am of the opinion, however, that several of the minor surgery books, published in this country, cover the subject more thoroughly.

EARLE I. GREENE

ACCORDING to the author, *Cancer Handbook of the Tumor Clinic*² is a brief, practical treatise designed for a graduate course, and presents the views and methods practiced in the Tumor Clinic of Stanford University. The booklet is a revision of a syllabus on the diagnosis and treatment of cancer published originally in 1937.

The manual opens with a discussion of the cancer problem and is followed by a chapter on the principles of radiation therapy. The other chapters deal with cancer of various organs. The treatise contains much valuable and interesting information about

cancer. The booklet is nicely compiled and the material is well arranged. Some of the photographs, especially those of melanomas of the conjunctiva and iris, are excellent. The author has undoubtedly succeeded in presenting some useful information on cancer in the brief space of 100 pages, but it is suggested that more care might be given to the selection of the bibliography in future editions.

MAX CUTLER

THE book entitled, *The Endocrine Glands*,³ is valuable. The author has had prolonged experience in clinical endocrinology. To this personal advantage is added an exhaustive presentation of references with each subject discussed. These references are introduced between sections of the text, a convenient form of arrangement which brings the literature to the immediate attention of the reader. History, pathology, and physiology are thoroughly discussed in each chapter. Many photomicrographs of the pathological histology of the endocrine glands are included. The author's views on treatment are given throughout, sometimes at variance with more generally accepted views, but these also are presented in full.

PAUL STARR

THE work of William Wolf entitled *Endocrinology in Modern Practice*⁴ is a large book and is evidently an attempt to present endocrinology to practitioners of medicine who may not have other references available. For such readers it is unfortunate since the subject is presented in a falsely suggestive manner. The discussion of many subjects is diffuse, including debatable material that is not critically debated and not documented in any way. Isolated reports of success with questionable procedures are given as suggestions for treatment in a manner that is quite like informal clinical gossip. This can lead only to the disappointment of the doctor and his patient and to the discredit of endocrinology.

After the presentation of endocrine diseases, 141 pages of unfounded speculation as to the possible endocrine factors in internal medicine are produced. Valvular heart disease, it is claimed, may be caused by diabetes with decided improvement when active antidiabetic treatment is given. An alphabetical catalogue of symptoms and their possible endocrine causes is given, such as pain in arm, Dercum's disease, hyperthyroidism, angina pectoris, brachial neuritis, rheumatism, fibrositis, myositis, and trauma.

The wholly misleading and unreliable catalogue of endocrine products, in which material for oral administration is given as prominent a place as potent injectible material, is again included. No evaluation is attempted. The American public must spend thousands of dollars annually on much of this

¹PYE'S SURGICAL HANDICRAFT. A MANUAL OF SURGICAL MANIPULATIONS, MINOR SURGERY AND OTHER MATTERS CONNECTED WITH THE WORK OF HOUSE SURGEONS AND OF SURGICAL DRESSERS. Edited by Hamilton Bailey F.R.C.S. (Eng.) 11th ed. Baltimore: The Williams & Wilkins Co. 1939.

²CANCER HANDBOOK OF THE TUMOR CLINIC, STANFORD UNIVERSITY SCHOOL OF MEDICINE. Edited by Eric Lillicrap M.D. Stanford University Calif. Stanford University Press 1939.

³THE ENDOCRINE GLANDS. By Max A. Goldzieher M.D. New York and London: D Appleton Century Co. Inc. 1939.

⁴ENDOCRINOLOGY IN MODERN PRACTICE. By William Wolf M.D. M.S. Ph.D. 2d rev. ed. Philadelphia and London: W B Saunders Co. 1939.

medicine the prescription of which is dishonest to the patient and disappointing to the doctor. It is unfortunate that it should be recommended in this publication.

P. VL. STARR.

THE second edition of *Sex and Internal Secretions* is the result of the collaborative efforts of 37 American authorities on the fundamental problems of sex. Each contributor has again reviewed, digested, and evaluated the fast moving field of his special interest. In this way the results of thousands of articles are reduced to comprehensive surveys linked with working bibliographies. The value of these labors to students, practitioners, and investigators is incalculable, since even a specialist can scarcely hope to keep pace with the progress in more than a few of the topics covered. No book exists in any language to challenge the supremacy of this work in authoritativeness or comprehensiveness.

Five major sections treat the following subjects: (1) the biological basis of sex; (2) the physiology of the sex glands, germ cells, and accessory organs; (3) the biochemistry and assay of gonadal hormones; (4) the hypophysis and the gonadotropic hormones of the blood and urine in relation to the reproductive system; and (5) additional factors in sex functions and endocrine applications in man.

Several new contributors cover certain closely related subjects which have made unusually rapid progress. Notable is the inclusion of all the experimental evidence concerning the endocrinology of sex function that is largely due to the great advances made in the chemistry of male and female hormones, and to the extensive study of the many functions of the pituitary and of the interrelations between endocrine glands.

To review adequately this monumental publication would doubtless be a challenge even to its editor. The present reviewer must limit his remarks to praise and gratitude for an accomplishment well conceived and admirably carried out. It is certain that the enthusiasm with which the first edition was received and the popularity which it deservedly merited will be extended to the new edition. This may be predicted with confidence because so many improvements and changes have entered that the former edition, after only 7 years of service, becomes to a large degree obsolete. In size alone 400 pages have been added to this second edition.

National pride will be gratified in observing how extensively and intensively American investigators have contributed to this field. Our country has become the center in which the most important discoveries from the newer attack in sex problems have been made. Still more remarkable is the degree to which anatomists, zoologists, and chemists have taken over this field. This trend is reflected in the roster of collaborators which includes but one physiologist and two clinicians.

L. B. ARRY.

SEX AND INTERNAL SECRETIONS. SURVEY OF RECENT RESEARCH Edited by Edgar Allen, Charles H. Dancforth, and Edward A. Dancy. With forewords by Robert M. Yerkes. Baltimore: The Williams & Wilkins Co. 1939.

THE publication, *Varicose Veins* is fully up to the standards long since set by these prominent medical writers. The work is condensed and to the point, yet the authors have not lost sight of the important subjects which are well covered.

The chapter on anatomy discusses the veins of the lower extremity in great detail which makes it easier to link up later the chapters on pathology of varicose veins and their treatment. Though the chapter on pathology of treated varicose veins is short, it makes the subject very clear and definite.

The authors have given more than usual space to the examination of the patient. This is justly so for it is probably the most important part of the treatment of varicose veins. This chapter is very replete with photographs and drawings which together with their tests make the study of the venous flow in varicose veins very clear and positive.

The chapter on treatment, which is particularly good, follows the principles and theories developed over a long period of time and portrays a large volume of work both clinical and private. However the chapter on varicose ulcer is very short and not up to the standards of the rest of the book. The authors seem less impressed with this complication.

It is a book well worth perusal by any one at all interested in this subject.

H. O. McFERRIN.

THE second revised edition of *A Textbook of Surgery* has appeared 3 years after the first edition was printed. The book is divided into 40 sections or chapters dealing with all branches of surgery. There are some 100 co-authors to the book which is 695 pages in length. The co-authors are active teachers and practitioners of surgery at the present time and the book represents an up-to-date opinion upon modern surgery. A number of recent changes in surgical opinions both as to therapy and surgical procedures are added by several new contributors of note. The editor has used good judgment in selecting his contributors, and with few exceptions has selected outstanding authorities upon the various subjects.

The new edition is quite timely as are all new editions of medical books. One would expect it to be possible to record more readily and accurately the rapid changes in surgical opinion and progress in books of this kind with many a thousand than in the ordinary textbook. It has many advantages over the usual textbook on surgery which contains so much repetition of previous editions. At the present time, with the intensive specialization, it is impossible for one or two authors to be qualified to do justice to all branches of surgery or even to a few of the specialties.

As a reference book for the surgeon, graduate student, general practitioner or even the internist, it

PLANNETRY. By Allen Graham, B.A., M.D. D.Sc. (Hon.), F.R.C.S. and Maxwell Maltby, B.A., M.D. M.S. (Surgery), F.R.C.S. In 2 vols. The C. Mosby Co. 1939.
 FEEDBACK BY SURGEONS. By American Authors. Edited by Frederick Christopher, B.S., M.D. F.R.C.S. 2d ed. Philadelphia and London: W. B. Saunders Co. 1939.

fills a great need in the rapidly changing surgical knowledge and practices. There may be some question as to its value to medical students as a textbook because of its exhaustive character, but for collateral reading and reference it is a great convenience, eliminating much lost motion used in searching the current medical journals. No practicing surgeon can afford not to have the book available for ready reference.

Let us hope its editor will continue the practice of frequent revisions as the occasion arises.

ALBERT O. SINGLETON

THE author of *Proctology for the General Practitioner*¹ has written a 375 page book especially designed to meet the needs of any general practitioner. It is a practical manual offering explicit and ready reference for the day to day problems in anorectal diseases.

In spite of the publication during the past two years of several very good volumes on rectal surgery, this book will fill a long vacant place in the general practitioner's library. It is definitely not a book for the proctologist or the general surgeon who is well grounded in the principles of rectal surgery. Unlike many recent books on this subject, which lead the general practitioner to believe he can treat all rectal conditions in his office, the author points out those conditions which are definitely not suitable for office care. Controversial matter and subjects of no real benefit to everyday practice have purposely been omitted.

One of the most useful chapters in the book is entitled "Anorectal Symptomatology." Bleeding, pain, protrusion, discharge, bowel habit, and anal itching are analyzed from the causative point of view. This should enable the practitioner, who does not frequently come in contact with rectal pathology, to make differential diagnoses.

History and examination are given adequate emphasis for this type of book. The endoscopic pitfalls, errors, and dangers of snap diagnoses are pointed out. The examination, from external inspection to sigmoidoscopy, is described with a running reference to the pathological conditions usually found in the various divisions of the anus and rectum. Pictures of instruments and proctological methods are freely utilized.

One chapter deals with the non operative as well as the operative treatment of internal hemorrhoids. The author lists nine different solutions for sclerosing internal hemorrhoids. This is bound to be rather confusing to the occasional rectal therapist. However, in general the technique of hemorrhoidal sclerosis is ably handled. The clamp and cauterization operation as described may give one the false impression that it is the operative procedure of choice.

There is a useful chapter on rectal, anal, and perineal symptoms of urogenital origin. As added

features, chapters are included on constipation, diarrhea, parasites, and therapeutic suggestions. This last consists of formulas for enemas, irrigations, and methods of relieving anal pain.

THOMAS JAMES MERAR

GROSS anatomy, the oldest and the most fundamental of the laboratory sciences contributing to medicine, finds itself today in the position of a pedagogical stepchild. From a traditional 1,000 hour course, it has in some quarters been compressed into a curtailed portion, managed by racy methods in one-fifth or even one-tenth of the original quota of time. Its hours have been reduced in number to make place for the new and necessary courses which teach technical methods essential to the specialties, for those which are designed to correlate the several divisions of a science, and for the courses which strive to bring into rational mental fabric the facts gleaned from laboratory and dispensary. Beleaguered by this enthusiastic medical soldiery, the anatomist finds it difficult to train his students with the old thoroughness. If he is to succeed in even the adequate discharge of this commission, the teacher of anatomy must put his students through their paces unhampered by any impediment, and give to the medical and surgical recruits only that information which is basic. In other words, it is necessary for the student to receive wise and skilled laboratory instruction, and books which are texts and not encyclopedias should be used.

In Professor Howell's *Gross Anatomy, a Brief Systematic Presentation of the Macroscopic Structure of the Human Body*² the teacher and student are presented with a treatise which is designed to meet these modern demands. The volume is concise, consisting of only one-third as many pages as the older books, yet it presents concepts as well as descriptive material. It has judiciously omitted histology and the microscopic portion of neurology, somewhat astonishing, and doubtless pleasing to some instructors, is the introduction of a proportionately large amount of comparative anatomical material.

Through much of the book the systematic accounts are handled with courageous brevity. In descriptions of the individual bones of the cranium, discussion of the complex articular relations is omitted, in the case of the long bones, the attachments of muscles are not presented with tedious detail, the section on each of the organs of special sense includes the accessory structures, that on the organ of sight, for example, including not only the eyeball, but the glandular, nervous, and vascular contents of the orbit, and the eyebrows and eyelids. In presenting the anatomy of the blood-vascular system similar brevity prevails, only the essential relationships of the larger trunks are given. The lymphatic glands and vessels are treated with un-

¹PROCTOLOGY FOR THE GENERAL PRACTITIONER. By Frederick C. Smith M.D. M.Sc. (Med.) F.A.P.S. Philadelphia. F. A. Davis Co. 1939.

²GROSS ANATOMY. A BRIEF SYSTEMATIC PRESENTATION OF THE MACROSCOPIC STRUCTURE OF THE HUMAN BODY. By A. Brazier Howell. New York and London. D. Appleton Century Co. Inc. 1939.

usual considerations the relations of the organs of the digestive and the urogenital systems are handled likewise.

Pictures are the mainstay of *Gross Anatomy*. Without iconography anatomy would be devitalized science, lose much of its traditional attraction and discharge but a colorless half-service to its students in whatever century. The figures which Professor Howell uses are ingeniously diagrammatic and usually original in conception; they are supplementary to those available in regular classes and admittedly they are not intended to portray the details of anatomical dissections. Of the 56 illustrations in the textbook about half or 27 are gross anatomical, several of these being purely schematic, 7 are

embryological, 7 comparative anatomical, and 5 neurological. The figures portraying developmental anatomy should prove serviceable in helping the beginner to understand the form and disposition of structures as they are encountered in the adult body; those showing the reflections of the peritoneum, the transformation of the primitive venous system, the development of the pharyngeal glandular derivatives, are useful additions to an anatomical textbook although they are not new in concept.

The explanatory notes on terminology and topography will be of assistance to the novice, as will also those introductory paragraphs to each chapter which present general information on the bodily systems. BARRY A. SOY.

BOOKS RECEIVED

Books received are acknowledged in this department, and each acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

OXFORD MEDICAL PUBLICATIONS. BLOOD TRANSFUSION. By Victor Horsley Riddell, M.A., M.D. (Camb.) F.R.C.S. (Eng.). London: Oxford University Press, 1930.

THE PARTICIPATION OF MEDICAL SOCIAL WORKERS IN THE TEACHING OF MEDICAL STUDENTS. Prepared by Harriett M. Bartlett for the Education Committee of the American Association of Medical Social Workers. Chicago: 1930.

HARVEY CUSHING'S SEVENTEENTH ANNUAL PARTY APRIL 8th, 1930. SPEECHES, LETTERS, AND THOUGHTS. Published for The Harvey Cushing Society, Springfield, Ill. Charles C. Thomas, 1930.

ACCEPTED FOODS AND THEIR NUTRITIONAL SIGNIFICANCE. Chicago, Ill. American Medical Ass. 1930.

OXFORD MEDICAL PUBLICATIONS. THOMSON'S MILLER'S MANUAL OF SURGERY. By Alexander Miller, M.D., LL.D., F.R.C.S. (Ed.) and The Late Sir David White, Vols. 1 and 2, 6th ed. London: Oxford University Press, 1930.

SCIENCE AND THE HUMAN BODY. PRACTICAL ANATOMY. By John Harold Couch, M.A., M.B., F.R.C.S. (Edin.) Toronto: The University of Toronto Press, 1930.

FISIOLOGIA DEL HEPATO-COLIBACIO COLONOSCOPIC OPERATORIA. By Pablo L. Muniz. Buenos Aires: Libreria y Editorial "El Alcega", 1930.

A TEXT BOOK OF GYNECOLOGY FOR STUDENTS PRACTITIONERS. By James Young, D.S.O., M.D., F.R.C.S.E., F.R.C.O.G. 5th rev. ed. London: Adam & Charles Black, 1930.



John P. Sullivan

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THE ESSENTIAL PRINCIPLES IN CLEAN WOUND HEALING

ALLEN O WHIPPLE, M D, F A C S, New York, New York

DURING the past 4 or 5 years, as a result of the regular surgical staff conferences and carefully analyzed case records in many of our hospitals, there has developed a renewed interest in problems of wound healing. This is a very healthy attitude on the part of our profession, and one encouraged by the American College of Surgeons in its demands for accurate records and open discussion of complications and poor results in the surgical staff meetings in our class A hospitals.

Many articles have appeared in the surgical literature during this period attributing improvement in wound healing, especially in clean wounds, to one type or another of suture material, to some special technique, or to such measures as air sterilization in the operating room. With so many contributions to this subject it is difficult for the busy surgeon to read with discrimination, and it may be an opportune time to point out certain fundamental principles underlying the healing of wounds which must be borne in mind in the care of wounds, especially those that we, as surgeons, make in the course of our regular work.

From time immemorial man has been subject to trauma. The savage who had the temerity to attempt to stop the flow of blood

From the Department of Surgery, Columbia University and the Presbyterian Hospital.
Presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 16-20, 1939.

and to close wounds caused by animal or human combat was looked upon with awe and respect. The first recorded accounts of human accomplishment depict the primitive surgery of the ancients. But it is only within comparatively recent time that the three dreaded terrors of wounds, hemorrhage, pain, and infection, have been controlled.

With the discoveries of anesthesia and bacterial cause of infection in wounds, general surgery made enormous strides. Following Lister's contributions in antiseptics and the more recent asepsis of the past 50 years, many surgeons—unfortunately, too many of the present day—have taken wound healing for granted if they conformed to the standard rules of accepted asepsis.

The essential principle of keeping out of the wound instruments, hands, sponges, and suture material that are not sterile has resulted in a marvelous improvement in wound healing in the world over. But there has been too great a tendency to attribute wound healing, especially clean wound healing, to a special technique, or to one kind or another of suture material, or to some kind of air filtration or air sterilization in the operating room.

For this reason it seems an opportune time to call attention again to certain underlying principles in the repair of wounds which must be kept in mind constantly when the value of any one technique or any new addition to our surgical armamentarium for the repair of

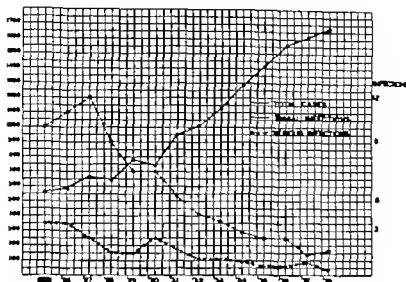


Chart Showing the decreased percentage of infection in wound healing from 1919-1931.

wounds is considered. At the expense of seeming to be dogmatic and with apologies for presenting well known facts these principles may be summarized as follows:

1. *Hemostasis* Hemorrhage in the course of repairing a wound must be controlled if the apposition of the wound edges or surfaces is to be accomplished. A large blood clot, even if sterile will delay the fibroplasia which unites the wound surfaces. But the control of bleeding must not be counteracted by the devitalization of tissue by the use of mass ligatures or heavy ligature material which favors infection and delays healing.

2. *Infection must be eliminated as far as possible* (a) It is absolutely essential to exclude virulent pathogenic bacteria by the use of sterilized instruments and supplies, intact gloves—the boiled hand—and by the careful masking of mouth and nose thus protecting the wound from the pathogenic organisms of the respiratory tract and oropharynx.

It is now generally recognized that the skin cannot be sterilized because of hair follicle and sweat gland bacteria not eliminated by any known germicide. But by careful preliminary cleansing with soap and water followed by a chemical bactericidal solution a relatively clean skin can be attained. Careful

exclusion of the skin edges during the operation, and keeping out of the wound contaminated gloves, instruments, and salt solution will minimize the skin contaminants. The central salt solution bowl, used on so many operating tables to wash or wipe instruments, is the most common unrecognized distributing focus in an otherwise aseptic technique. Instruments coming out of the wound should be discarded and reboiled, not touched, wiped, or polished by the diligent, well intentioned, but inexperienced student nurse or assistant.

b. *In accidental wounds*, unfortunately so common in our day of motor accidents and world wars the devitalized contaminated tissues must be cut away and the wound thoroughly irrigated with sterile normal salt solution. The late war demonstrated this, and subsequent years have corroborated this essential principle.

c. *Foreign bodies* such as heavy ligatures, sutures, and drains should be reduced to a minimum. Drains should never be used in the repair of clean wounds unless uncontrolled hemorrhagic ooze threatens vital structures by pressure of blood clot or retained blood. Foreign bodies predispose to infection in a wound which otherwise would take care of contaminating bacteria.

d Bacteriostasis by means of chemotherapeutic measures During the late war the use of Dakin's solution with various modifications of the Carrel technique demonstrated the more rapid healing of contaminated wounds than with ordinary dressings Débridement of contaminated wounds was shown in the latter part of the war to be more important in obtaining primary union

In the last 3 years a new principle of introducing into the body and interstitial fluids a bacteriostatic substance in the form of an azo dye containing a sulfonamide group has very largely revolutionized our treatment of hemolytic streptococcus infections In the form of sulfanilamide, prontosil, and sulfapyradine, various salts of the azo dye are administered by mouth or parenterally to combat hemolytic streptococcus, pneumococcus, and colon bacillus infected wounds and as a means of preventing potentially contaminated wounds from becoming infected These dyes act as bacteriostatic rather than bactericidal agents, giving the normal body defense mechanisms of the leucocytes, reticulo-endothelial cells, and immune bodies the upper hand in disposing of bacteria in the blood, in the tissues, or on wound surfaces before they have a chance to multiply and destroy tissue They are especially effective in the rapidly diffusing and virulent forms of hemolytic streptococcus infections, such as streptococcus lymphangitis, cellulitis, and erysipelas

3 *The severed tissues should be replaced and maintained in apposition to as nearly normal anatomical relations as possible* This is relatively easy in clean incised wounds, especially those made by the surgeon in his approach to surgical lesions, but it may be difficult or impossible in lacerated or inflamed tissues In accomplishing this apposition and maintaining it, mechanical measures of suturing and pressure have been developed and are used by the surgeon But in applying these mechanical measures he must constantly bear in mind the following great and most important principle so often disregarded by the mechanically minded surgeon

4 *The restoring and maintaining of nutrition of the tissues involved in the wound is important* Devitalized tissue means necrosis

TABLE I — WOUND HEALING BY SUTURE MATERIAL—CLEAN CASES, 1932-1938

Year	No of cases		Percentage of infection	
	Silk	Gut	Silk	Gut
1932	656	306	2.3	9.2
1933	526	357	3.0	8.0
1934	864	316	2.0	7.0
1935	994	423	2.7	4.0
1936	1,149	407	7	4.4
1937	1,06	318	1.9	4.1
1938	1,130	374	1.8	3.5
Total	6,615	2,435	2.3	5.7

and inevitably infection, which the healing process in the tissues may or may not be able to handle This maintenance of nutrition, or avoiding of devitalization, of the tissues in and about the wound is dependent upon (a) preserving the blood supply to the tissues, as far as possible, by avoiding mass ligation of vessels and their surrounding muscle and fascia, using fine pointed, instead of blunt, hemostats, and ligatures that do not have a tensile strength more than double that of the tissues ligated, (b) reducing to a minimum the trauma caused by blunt hemostats, large needles, and heavy suture material, and the tension of tight sutures in repairing the wound, and (c) avoiding the application of pressure to the closed wound, by dressings and bandages, greater than the impaired circulation in the repaired tissues will stand

5 *The patient and the repaired wound should be placed at rest* This can be accomplished (a) by eliminating pain during and after operation The proper selection of the anesthetic and pre-operative and postoperative sedatives is essential, (b) by supporting and immobilizing painlessly the repaired parts until fibroplasia and nutrition of the wound edges are completed, and (c) by eliminating tissue tension caused by tight sutures, muscle spasm, and distention In many wounds tissue tension causes pain and this results in muscle spasm In the abdomen this predisposes to pulmonary complications and wound disruption Bowel distention in intestinal anastomosis results in tissue tension on the suture line, leakage with peritonitis, or fistula

formation. The use of the Miller Abbott tube in intestinal resection has eliminated the use of enterostomy and has reduced the hazard of ileus more than any other known therapeutic measure.

6 *Normal tissue metabolism should be restored and maintained.* Great advances in blood chemistry have been made recently in this field of therapy by determining and maintaining (a) fluid and electrolyte balance (b) carbohydrate metabolism (c) proper elimination of body excretions and (d) by preventing and correcting cardiovascular disturbances.

With these principles understood and appreciated by the surgeon in the course of his training it is most gratifying to observe how inevitably his solicitous care develops in the closure of his wounds and how invariably he demands finer instruments and finer sutures and ligatures in repairing tissues. Whether he uses catgut or silk is of little importance provided he has the philosophy and the solicitous interest in repairing accidental wounds or the ones he has to make in the course of his surgery. If he has these he will develop standards and a critique that will not tolerate unnecessary tissue trauma and slovenly wound repair. He will insist upon closing his own operative incisions. He will keep

careful records of his wound healing and will strive for the 99 per cent of clean wound healing knowing that the 100 per cent is a limit approached but never actually reached.

Recently in the Listerian Oration delivered at the meeting of the Canadian Medical Association in June of 1939, the speaker called attention to the effect of carefully observing and recording clean wound healing with an annual reporting of the results in a clinic having an adequate bacteriological laboratory under the supervision of a surgeon trained and interested in bacteriology.

All real surgeons have been interested in wound repair. Paré, John Hunter, Lister and Halsted were constantly studying the care of wounds, and contributed fundamentally to the permanent literature on the subject. They were zealous in the training of the young surgeon in this phase of his science and art. Certainly there is no more durable satisfaction than that of watching the development of a constructive attitude in wound healing in the resident surgeon during his apprenticeship. Inasmuch as we make wounds in our work as surgeons, we certainly should be constantly striving to repair these wounds in as ideal a manner as possible. This is a tradition unique in our profession and we should cherish it.

state that 'pulmonary tuberculosis provides the most extreme example of the increased consumption of vitamin C. The daily excretion for a standardized diet falls to about one third the controls, and the response to three days testing dose is negligible.' Martin and Hesse demonstrated the existence of a hypovitaminosis due to a lack of vitamin C in a large majority of tuberculous patients, and the degree of hypovitaminosis was found to parallel the extent and activity of the tuberculous process. Greene Stelner and Kramer showed that generalized tuberculosis developed more rapidly in animals chronically deficient in vitamin C than in non-scorbutic animals and that chronic vitamin C deficiency combined with a tuberculous infection causes a significant shortening of the survival period. Leichentritt gave large amounts of orange juice to tuberculous guinea pigs on normal diets and found the survival period to be twice as long as that of tuberculous animals on a normal diet alone.

Similarly Harde Rothstein and Ratish found a very low rate of excretion of vitamin C in pneumonia which indicated an increased consumption of this vitamin in this disease. Vogl applies this knowledge in his treatment of pneumonias by large doses of vitamin C. As soon as pneumonia is diagnosed the patient receives 200 milligrams of ascorbic acid subcutaneously followed by daily doses of from 200 to 500 milligrams, depending on the severity of the disease. Pulmonary abscess, chronic pneumonia, or carnification never occurred in cases treated in this manner.

In a study of 17 active cases of osteomyelitis (17 semi-cured patients, 16 healed, and 10 controls) Abassy Harris, and Hill (2) found a diminished rate of excretion of vitamin C in the urine and a lowered response to test doses of vitamin C indicative of an apparently increased usage of this vitamin during the infective process, greatest in the active cases intermediate in the semi-cured and normal in the healed.

The frequent occurrence of vitamin C deficiency suggests that other vitamins may be equally deficient. Jeans and Zentmire using the ability to adapt to the dark as a test for detecting vitamin A adequacy found that 26

per cent of a rural group and 53 per cent of a village group of Iowa children presented evidence of vitamin A deficiency.

Jeghers in a study of a group of medical students who presumably should be on fairly adequate diets, found that 35 per cent were deficient in vitamin A as determined by photometric tests, and 12 per cent had clinical manifestations of the deficiency. The chief manifestations of such deficiency were night blindness, photophobia, dry skin, dry conjunctival blepharitis, and follicular hyperkeratosis. Evidence was also obtained from this study that infections were more numerous and severe among the deficient students.

Thirty-eight patients entering the Stanford Lane Clinic for medical and surgical care were studied by the Hecht apparatus for dark adaptation this being considered a moderately accurate indication of the degree of vitamin A sufficiency or deficiency. To our astonishment, 10 patients, or 26 per cent showed a marked deficiency in vitamin A, 9 or 24 per cent, showed a mild deficiency, 10 or 26 per cent, were normal and 9 or 24 per cent showed a supersufficiency of vitamin A in their diets. In other words, one-half of the ordinary run of the mill patients who present themselves to a free clinic for treatment are deficient in their intake of vitamin A. Eight patients, or 20 per cent, were night blind.

The effect of such vitamin A deficiency is most pronounced on the epithelial structures (67). These undergo an atrophy followed by a reparative proliferation of the basal cells, replacing the normal columnar cells by a stratified keratinizing epithelium. This keratinizing metaplasia involves (1) the salivary glands, including the submaxillary, parotid, and all accessory glands of the tongue buccal cavity and pharynx, (2) the respiratory tract, including the nares maxillary sinuses, trachea, and bronchi, (3) the genito-urinary tract, including the renal pelvis ureters, bladder epididymis, prostate, seminal vesicles, uterus, and vulva, and (4) the eyes and peri-ocular glands. This metaplasia results in the accumulation of keratinized cells in glands and their ducts and in organs such as the lungs and leads to the occlusion of bronchi, the

formation and filling up of bronchiectatic cavities with keratinized cells, and atelectasis. These changes are presumably responsible for the spontaneous infections that occur so frequently in the mouth, the salivary glands, and the genito-urinary tract of animals on vitamin A free diets (26, 39).

The importance of normally functioning epithelial surfaces in surgical patients needs no elaboration. Healthy epithelial tissue is undoubtedly a more efficient barrier to infection than epithelium whose structure has been altered by a vitamin deficiency. Parotitis, purulent bronchitis, pneumonia, and urinary infections are postoperative bugbears. To operate on patients deficient in vitamin A is inviting the development of such complications. According to Wolbach "the early effect of the deficiency on the respiratory mucosa is a satisfactory explanation of the frequency, severity and persistence of the pneumonia that has been responsible in most instances for the death of infants deficient in vitamin A."

That vitamin A deficiency may occur through faulty absorption due to hepatic or gastro-intestinal disease is suggested in isolated case reports. Among these may be mentioned night blindness in a man with a gastrocolic fistula following a gastric operation (65), xerophthalmia in a patient with hepatic cirrhosis (55), and in a patient with hepatic cirrhosis secondary to carcinoma of the liver (6). The association of chronic jaundice, night blindness, and xerophthalmia (3), though still unexplained, has led to the assumption that bile is necessary for the proper absorption of vitamin A. In experimental biliary fistulas, Greaves and Schmidt (24) found that vitamin A was absorbed only if supplied orally with bile salts. On present knowledge then, when giving vitamin A to patients with jaundice, bile salts should also be administered. The parenteral administration of vitamin A is occasionally indicated. Finkelstone et al. have administered a high concentrate (100,000 vitamin A units and 12,500 vitamin D units per cubic centimeter) to pregnant women in dosages of 1 cubic centimeter every fortnight with safety. Chu and Lin studied 3 infants and 6 adolescents who showed various degrees of xerophthalmia

due to vitamin A deficiency with an associated diarrhea. An improvement of the eye condition was noted within 2 days after the intramuscular injection of avoleum, a vitamin A concentrate containing 20,000 units per gram. It was injected in divided doses of 1 and 2 cubic centimeters in different areas. The beneficial effect of a single dose of vitamin A concentrate given parenterally may last as long as 2 months.

Vitamin B deficiency is not so accurately determined, but certain qualities of the vitamin make it important in the surgical patient. Vitamin B has a stimulating action on the growth of plants. In periods of active growth there is a corresponding increase in requirements of vitamin B, i.e., infants and growing children require a much larger daily supply than adults. The polyneuritis, the weakened cardiac musculature, the atonic and weakened gastro-intestinal musculature with its associated anorexia, intestinal atony, and constipation are the more common results of vitamin B deficiency (15). Their avoidance in the surgical patient is vital. It has been stated that these symptoms of vitamin B deficiency remain latent at times and appear only with the onset of some intercurrent infection, during pregnancy, after a surgical operation, or other event which requires an increased bodily metabolism. It is significant that in the experiment on 300 Javanese, general physical impairment occurred long before the symptoms of beriberi appeared.

According to Cowgill the vitamin B requirements in man bear a direct relationship to metabolism and are increased in diuresis and diarrhea. Inasmuch as there is a very limited capacity for storage of vitamin B in human tissues, Frazier and Ravdin argued that the vitamin B requirement should be increased in hyperthyroidism. Accordingly they administered to a group of hyperthyroid patients 10 milligrams of crystalline vitamin B₁ every other day and 10 grams of brewer's yeast daily by mouth, with a demonstrable improvement in their nutritional state, a greater fall in pulse rate, and a shorter pre-operative period of preparation for the very ill patient.

Another mode of action of vitamin B may be related to an observation by Manville and

Grondahl who found that the regeneration of red cells is possible only if yeast or some factor in yeast is included in the diet. Erythrogenesis in rats on a basal diet excluding the vitamin B maturation factor stopped at the megaloblastic stage. Some factor in yeast was necessary to carry the megaloblast to the normoblastic stage. The importance of this observation in the restoration of the normal blood volume immediately following severe blood loss at operation cannot be over estimated.

Of major importance in the preparation of the jaundiced patient for operation are 2 recently discovered facts first, that the bleeding which so easily and so frequently occurs in these patients, is due to a low level of prothrombin in the blood and secondly that for the formation of this prothrombin, presumably in the liver a specific food factor designated as vitamin K is indispensable (16-17). The vitamin is found in alfalfa, spinach, and kale, or it may even be synthesized in the lower intestine through bacterial activity. As it is a fat soluble substance bile is necessary for its absorption. In the patient with jaundice with a biliary fistula, with an intestinal fistula or with prolonged duodenal stypnosis as in intestinal obstruction bile does not reach the lower intestine vitamin K is not absorbed the prothrombin cannot, therefore, be formed. It falls to low levels in the blood and fatal bleeding may occur either spontaneously or following the trauma of operation (60).

In the pre-operative preparation of the jaundiced patient, not only is the administration of vitamin K imperative but also the administration of bile salts (11). The quantity administered depends largely upon the level of the prothrombin in the blood. This is determined according to the method of Quack (57-58). Patients with a normal prothrombin clotting time are treated prophylactically with 2000 to 6000 units of vitamin K, together with 1 to 4 grams of bile salts daily. Patients with a prolonged prothrombin clotting time, without bleeding, and those actively bleeding receive correspondingly larger doses.

If the liver has been injured by poisons, infections or new growth, the level of pro-

thrombin in the blood also falls. In such instances there is, however, no vitamin deficiency but a destruction of the site where prothrombin is formed and vitamin K will not correct the condition. The administration of this vitamin is equally useless in the bleeding of hemophilia, thrombopenia, or aplastic anemia. But the hemorrhage that occurs in jaundice, in intestinal obstruction from any cause in intestinal or biliary fistulas, in prolonged diarrhea, or in ulcerative colitis, may be controlled by the administration of this vitamin together with bile salts.

Additional evidence of the importance of the pre-operative nutritional preparation of the surgical patient is presented in the experimental observations of Thompson, Ravdin and Frank. In 8 out of 11 dogs operated upon in a hypoproteinemc state, the wound failed to heal and a disruption occurred. As early as 1919 Clark showed an improved repair in dogs on a high protein diet, and Harvey and Howes showed an accelerated fibroplastic proliferation on a similar high protein diet. Ravdin states that a liver high in fat and low in protein is maximally susceptible to injury. A liver low in fat and high in available protein is maximally resistant to such injury. These observations gave added support to our practice of giving surgical patients a balanced diet of high caloric value in the pre- and postoperative periods. In appropriate cases, Thompson et al suggest restoring the serum protein to normal levels by the intravenous infusion of lyophilic plasma.

As these various studies suggest our knowledge concerning nutrition though rapidly and phenomenally progressing, is still in its infancy. Well may we ask how do the vitamins act? What is their fate after their ingestion? It is probable that they are not specific in their effects, although many attempts have been made to attach the attribute anti-infective to vitamin A. As the exact chemical structure of the vitamins unfolds, it appears that it approximates in some degree the chemical structure of the endocrine hormones. The hexuronic acid isolated by Szent Gyorgi from the adrenal cortex in considerable quantity proved to be identical in structure with vitamin C. Freeman and Glass

found a definite relationship between vitamin C level of the blood plasma before death, and the incidence of central autolysis of the adrenal glands at autopsy. If the reduced ascorbic acid value was above 0.70 milligram per cent, no central cavities were found in the adrenal glands, while on the other hand, if the value was below 0.70 milligram per cent, central cavities were invariably present. Harris, Passmore and Pagel found that guinea pigs, suffering from an acute infection with *pasturella pseudotuberculosis*, showed a considerable diminution in the amount of vitamin C present in their suprarenal glands as compared with controls which had received the same amount of vitamin C. The vitamin C in the liver, on the other hand, was not significantly affected. Normally the pituitary and adrenal glands are said to contain vitamin C in greater abundance per gram of gland substance than any other known substances. The liver has been credited with being a storage depot for vitamin A. In cirrhosis, Moore has found vitamin A in very low concentration.

In view of this evidence, are we not justified in assuming that in order that the liver and the all important endocrine organs may function normally, they must be properly nourished through an adequate supply of vitamins? With these organs functioning in optimum efficiency, due to optimum nutrition, one may logically infer that the patient is better able to meet the ordeal of operation, to heal the disrupted tissues more kindly, and to avoid the distressing complications of infection and delayed repair.

With the additional convincing evidence that many patients live in a chronic state of vitamin deficiency, should we not insist that whenever possible a few days be assigned before operation to the necessary nutritional preparation of the surgical patient? "Ideally, every patient should be hospitalized one or even two weeks before operation with the avowed intention of improving general nutrition and of restoring the depleted store of vitamins" (36).

In a study of the vitamin C content of human tissues, Yavorsky, et al., found a consistently diminished content in all tissues

studied: adrenal, brain, pancreas, liver, spleen, kidney, lung, heart, and thymus, in those patients from 46 to 77 years of age as compared to the patients from one to 46 years of age. This suggests that the older patients require a longer period of preparation by high vitamin intake than the younger patients. Orr's observations indicate further that patients from low economic levels show correspondingly increased frequency of vitamin deficiencies.

Fortunately, the effects of vitamin lack are corrected quite promptly. Reparative changes in the metaplastic epithelium begin as early as the fifth day following the ingestion of suitable amounts of vitamin A. A low ascorbic acid content of the blood is corrected within 3 to 5 days after adequate intake. Even a few days, therefore, spent in nutritional preparation of the patient should reduce the operative hazard and diminish the length of convalescence. There is little justification for the almost universal practice of admitting the candidate for an elective operation on one day and operating upon him the next. The ordeal of operation with its attendant risks should, whenever possible, be undertaken only in patients in a state of optimum nutrition.

SUMMARY

1. Seventy patients, from low economic levels, admitted to the Stanford-Lane clinic wards for operation were studied with respect to the vitamin C content of their blood. In 44 per cent of these patients, values of 0.15 to 0.30 milligram per 100 cubic centimeter of blood were found, indicative of a low vitamin C intake. In 9 patients, values fell below 0.15 milligram per cent, indicating they were on the verge of clinical scurvy.

2. This evidence of deficiency in vitamin C is of extreme importance in surgical patients, since ascorbic acid or vitamin C is intimately concerned with the synthesis and maintenance of the intercellular supporting materials which provide the framework of healing. Experimental observations by Lanman and Ingalls showed that abdominal wounds of scorbutic animals ruptured at a pressure one-third that required to rupture the wounds of normal animals.

3 Thirty-eight patients entering Stanford Lane Clinic for surgical and medical care were studied by means of the Hecht adaptometer. Ten patients or 26 per cent, showed a marked deficiency in vitamin A, 9 showed a mild deficiency, 10 were normal and 9 showed a supersufficiency of vitamin A.

4 Observations by Jeans, Zentmire and Jeghers showed that 24 to 36 per cent of the ordinary population were deficient in vitamin A.

5 Since the effect of vitamin A is to produce metaplastic changes in epithelial structures a deficiency in this vitamin is of real importance in patients who following operation, are threatened with infections of such epithelial structures as the salivary glands, the bronchi, the lungs, the gastrointestinal canal and the genito-urinary system. Animals on diets deficient in vitamin A develop abscesses and infections in these regions.

6 Experimental observations by Thompson and Ravdin indicate that animals on a low protein diet show impaired healing and disruption of wounds in 72 per cent. Howes and Harvey found an acceleration of fibroplastic proliferation in animals on a high protein diet.

7 These observations indicate that surgical patients should, whenever possible be prepared for operation by several days of optimum nutrition including a well balanced diet of high protein intake of high caloric value, and of high vitamin content. This period of preparation should begin at home 10 to 14 days before operation.

8 This preparation should also include vitamin concentrates for 5 to 7 days before operation, 2 haliver oil capsules thrice daily, 3 B concentrate tablets thrice daily, juice of 4 oranges and 2 lemons daily.

9. Patients with obstructive jaundice with biliary or intestinal fistulas with intestinal obstruction, ulcerative colitis or persistent diarrhea, may show a prolonged prothrombin clotting time due to a low level of prothrombin in the blood, secondary to absence or faulty absorption of vitamin K. Before operation as a prophylactic measure, or if and when bleeding occurs, such patients should receive massive doses of vitamin K and of bile salts. The

latter are indispensable in the absorption of the vitamin.

10. In emergency operations, the parenteral administration of vitamins A, B, C and in the jaundiced patient, vitamin K is indicated.

11 Following operation optimum nutrition should again be instituted through a well balanced, high caloric, high vitamin diet, supplemented by vitamin concentrates throughout the full convalescent period.

12 The ordeal of operation with its attendant hazards should be undertaken whenever possible only in patients in a state of optimum nutrition. For the past 11 years, patients admitted to the Stanford Lane clinic wards under my control have been prepared for operation by a high caloric, high vitamin diet, supplemented by vitamin concentrates.

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RE-ESTABLISHMENT OF THE GASTRO INTESTINAL PASSAGE AFTER GASTRIC RESECTION

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THE year 1938 marked the sixtieth anniversary of gastric resection. It was on April 9 1878 that Péan, the famous surgeon of Paris, performed the first gastrectomy. The idea was much older however for it seems that it was in the town of Philadelphia that the first experiments with resection of the pylorus of dogs and rabbits were made. At least, so says D. C. Th. Merrem, whose treatise of 1810 is generally quoted as first propagating the idea of pylorotomy. A hundred years ago Dieffenbach, the greatest surgeon of his time wrote "The removal of gastric cancer is a dream of Merrem!"

There elapsed less than 40 years before the dream came true. After Péan, first Rydger and later Billroth performed gastric resection, and this operation done in January 1881 was successful and the patient recovered. The technique used in these first three gastric resections was the same: the adequately narrowed stump of the stomach was united with the duodenum. This method is called the Billroth I operation.

In 1885 Billroth operated upon a patient in whom he found a large cancer of the stomach. The patient was so very feeble that in Billroth's judgment, it would be impossible for him to survive extirpation of the tumor. Therefore Billroth made a gastro-enterostomy. The patient withstood this operation so well that Billroth decided he could withstand removal of the tumor as well. He therefore extirpated the tumor and closed the lines of resection of the stomach and duodenum. Thus the first Billroth II operation was accomplished.

Billroth thought that this "atypical" operation the combination of a Woelfler's gastro-enterostomy with resection of the stomach as they then called it would be suitable in

cases in which the stumps of the stomach and the duodenum could not be easily brought together after the removal of a cancer. But it soon became apparent that the Billroth II operation was not only easier but also generally much safer than the Billroth I operation, and so the Billroth I operation was gradually abandoned: the majority of the surgeons showing preference for the Billroth II technique.

If the cancer is very large however after its removal the stump of the stomach may be so small that even the Billroth II technique may present some insurmountable difficulties. If one would occlude the small stomach stump as required by this operation it would be so reduced in size that there would be no place for the gastro-enterostomy. Therefore in such cases one must refrain from closing the stomach stump but instead implant the whole of it into the jejunum. This is the essential feature of the method to which I have had the honor to call attention. It originated as a

"I was not the only one nor the first who got into difficulties and found my way out by reversing this method, but I realized at least its great practical value and so at once that it was not only a method of necessity but the method of choice in the majority of cases and, therefore, new to it that it should be done publicly because it was absolutely correct. The method was quite unknown, not only to myself but to all my colleagues with whom I had the opportunity to discuss it and I readily looked for descriptions of it in the textbooks and journals. I had no success to me."

"I demonstrated my first patient operated upon by this method in October 1910, before the surgical society of Budapest and spoke of this operation at the Congress of the German Surgical Society in Berlin (Verhandl. d. deutsch. Chirurgenkongresses 1910) and here I saw but no one there knew of anything similar. I decided to publish a description of the technique. I had, however, in the Zentralblatt für Chirurgie, which appeared in a few weeks later, W. Klose, then director of the surgical clinic of the University of Heidelberg, read an article in the Zentralblatt für Chirurgie of No. 1, in which he stated that few months previously even before reading my report he had used a method similar to mine but with certain differences. I then verified these changes of No. 1. Reichel, located in Bonn, but who he had mentioned at the 1904 Congress of the German Surgical Society in discussing a paper of W. Klose, in his report mentioned operations (after asphyctic gastroenterostomy) he had performed 3 operations of the kind described by me. At the same time W. Klose, of Regensburg, reported of 1 article in the Zentralblatt für Chirurgie of No. 1, in which he reported on cases operated upon in the same manner. I did not know of Reichel's article nor did W. Klose nor did I see his any body else to him."

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necessary means to an end, but it proved to have some advantages over the Billroth II method, the chief of which is the saving of time by omitting the closure of the stomach stump. And so as the Billroth I method was abandoned for Billroth II technique because the latter was simpler and easier, the Billroth II operation likewise was willingly replaced by another method which seemed still simpler and easier.

Simplicity and easiness of performance, especially if the method is time saving, are certainly very important points in every operation, and not only the surgeon but also the patient who has to undergo the operation is thus benefited. Other points must also be considered, however, and one must thoroughly investigate the merits and faults of the different operative methods before he is able to decide which is the best—and often if one is just, he arrives at the conclusion that one cannot draw any general conclusion, for one method is best for a certain group of cases and another for other cases.

RE-ESTABLISHMENT OF GASTRO-INTESTINAL CONTINUITY

The manner of re-establishing gastro-intestinal continuity after gastric resection is certainly the most characteristic feature of the method employed for it and it is certainly a most important point in technique. It is by no means, however, a purely technical problem, nor should the technical side of the question be considered as the most important one.

I had spoken before. The great surprise, however, came in 1916 when Narath published an article in the *Deutsche Zeitschrift fuer Chirurgie* Vol. 136 which showed that von Hacker had advocated the idea of connecting the opening of the stump of the stomach directly with the jejunum and that it was Kroenlein in 1885 who first performed such an operation (antecolic Fig. 8 a) and that since then many surgeons including Erlesberg (Fig. 8 b), Mikulicz, Doyen, Graser (Fig. 8 c), Hofmeister, Dela-gèrie, Sasse and others published reports of cases in which this principle was followed with various alterations in technique (antecolic, retrocolic, narrowed and unnarrowed stomach stump). These were presented usually in casualistic publications and in demonstrations before medical societies which generally do not awake public interest. Thus it happened that not one of the surgeons who did the operation knew of the others who had been doing it and most of those who were doing it looked upon it as a method of exceptional value when necessity demanded but not as a measure of great general practical value.

The great majority of surgeons, however, did not know of the method at all until I called it to the attention of the surgical world, and especially to the attention of William Mayo who saw in it the operation of the future and who endorsement helped to make it one of the most widely adopted.

The first thing to be remembered is the welfare of the patient which implies perfection and durability as well as safety of the cure, or at least something which is as near to these requirements as possible. The immediate safety of operation is purely a necessary preliminary, a *conditio sine qua non* for the two others, but one should always strive to secure with an equal or eventually higher degree of safety a better end-result. Also it is of advantage if one is familiar with more than one method so that he may choose the most suitable technique for the case at hand and what is still more important—select one suitable in an atypical case.

And, therefore, I think it is not superfluous to glance over the many possible methods for re-establishing the gastro-intestinal passage after resection and at the same time to revise the terminology, choosing a term which will express all, or at least all the more remarkable, characteristics of the method. Narath suggested a nomenclature to designate resections with gastrojejunostomies, but it was not complete, and in some respects not quite satisfactory. The prominent features of the different methods used for restoring gastro-intestinal continuity depend chiefly upon

- 1 The form of anastomosis, whether end-to-end, terminoterminal, end-to-side, lateroterminal, or side-to-side, laterolateral.

- 2 The part of the intestine used for the connection with the stomach stump whether the duodenum or jejunum. The method then should be named gastroduodenostomy (duodeno-gastrostomy) or gastrojejunostomy (jejunogastrostomy). Since with end-to-side anastomoses one can implant the end of the stomach stump into the side of the intestine or else the intestine into the side of the stomach stump, one may mention first the organ which is implanted in the other.

- 3 The special points which vary with the various kinds of anastomosis. With end-to-side anastomoses for instance, when the stomach stump is implanted into the side of the intestine this may be implanted narrowed or unnarrowed, and one may narrow the stomach stump by occluding the part which is in the vicinity of the lesser curvature or that part which lies at the greater curvature.

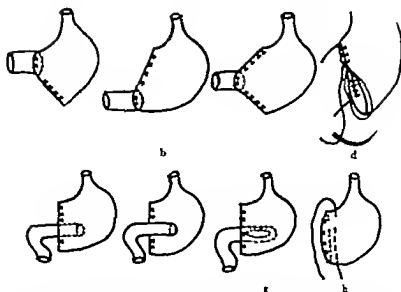


Fig. 1. Gastroduodenal anastomoses. a, End-to-end gastroduodenostomy with narrowing of the stomach stump at the greater curvature (Gussenbauer and Wienwarter-Rydygier). b, end-to-end gastroduodenostomy with narrowing of the stomach stump at the lesser curvature (typical Billroth I). c, end-to-end gastroduodenostomy with narrowing on both curvatures. d, method of J. Shelton Hoxley. e, posterior end-to-side duodenogastrostomy (Kocher). f, anterior end-to-side duodenogastrostomy (modified Kocher). g, side-to-side duodenogastrostomy (Ito and Soyessima). h, end-to-side gastroduodenostomy (Finney-Haberer).

If the jejunum is used for the anastomosis with the stomach, there will be differences corresponding to the position of the anastomosing loop to the transverse colon and with the presence or absence of entero-enteroanastomosis and its form: side-to-side (Braun) or Y-shaped (Roux). If side-to-side anastomoses are made there will also be differences depending upon the part of the stomach used for the anastomoses. These peculiarities should be expressed by appropriate adjectives.

Anastomoses of the stomach with the duodenum (Fig. 1) are (a) end-to-end gastroduodenostomy the Billroth I method; (b) end-to-side gastroduodenostomy as advised by Finney-Haberer; (c) posterior end-to-side duodenogastrostomy the Kocher operation; implantation of the duodenal stump into the posterior wall of the stomach; (d) anterior end-to-side duodenogastrostomy—a modification of the former operation—implantation of the duodenal stump into the anterior wall of the stomach; (e) side-to-side gastroduodenostomy as suggested by Ito and Soyessima, in which

the stump of the duodenum and stomach are both closed, and the anastomosis is made between the anterior wall of the duodenum and the posterior wall of the stomach.

Anastomoses of the stomach with the jejunum are (a) End-to-end gastrojejunostomy necessarily combined with end-to-side jejunojejunal anastomosis (Y-shaped). It may be antecolic (Rydygier) or retrocolic (Mozzkovick) (Fig. 2 a and b). (b) End-to-side anastomoses are to be divided into two groups: first, implantation of the stomach stump into the jejunum and second, implantation of the aboral stump of the transversely cut jejunum into the stomach.

End-to-side gastrojejunostomy may be done in several ways. (a) Depending upon the relation of the jejunum used for the anastomosis to the transverse colon it may be antecolic (Fig. 3) or retrocolic (Fig. 4). (b) It may be done without and with narrowing of the stomach stump (total and partial) and the narrowing may be done in the neighborhood of the lesser or the greater curvature—partial

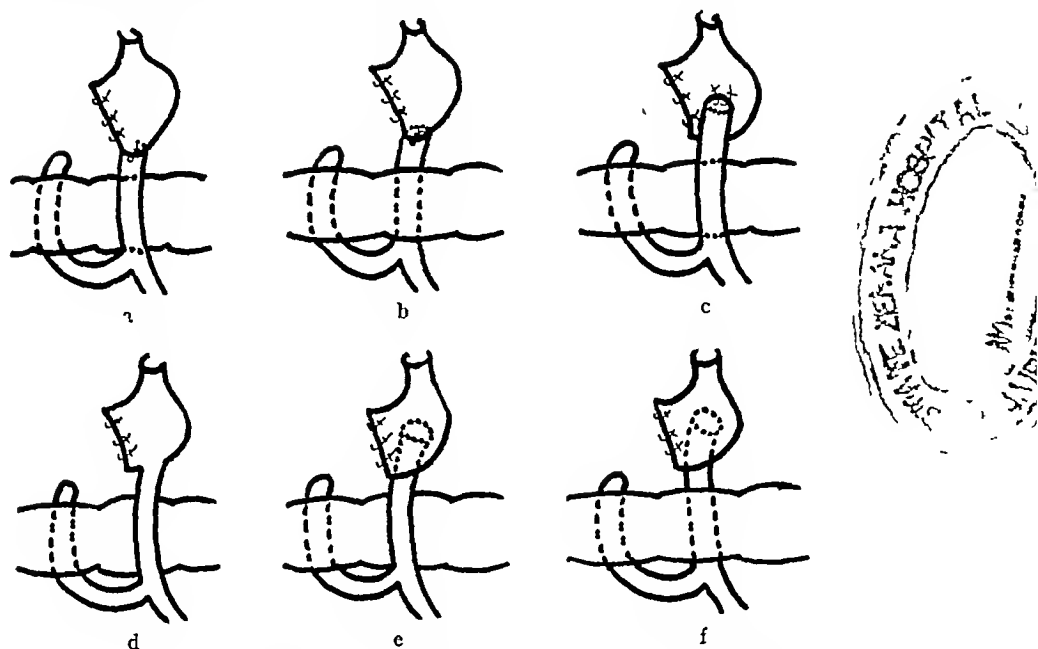


Fig 2 a, Antecolic end to end gastroduodenostomy (Rydygier II), b, retrocolic end to end gastroduodenostomy (Moszkowicz), c, antecolic anterior end to side jejunojejunostomy, d, antecolic inferior end to side jejunojejunostomy, e, antecolic posterior end to side jejunojejunostomy, f, retrocolic posterior end to side jejunojejunostomy

inferior and superior, according to the site of the opening (c) It can be performed without and with lateral entero-entero-anastomosis In other words there are altogether 12 possibilities in this group alone The antecolic total end-to-side gastroduodenostomy is the Kroenlein-Balfour operation, the antecolic superior partial end-to-side gastroduodenostomy, is the modification by Mayo, and occludes the inferior part of the stomach stump and leaves it open in the vicinity of the lesser curvature

End-to-side jejunojejunostomies (Figs 2, 3-6) are combined necessarily, as the end-to-end gastroduodenostomies described under section (a), with Y-shaped end-to-side jejunojejunostomies The jejunum may lie before and behind the transverse colon and may be implanted into the anterior or posterior wall of the stomach or its greater curvature There are, therefore, 6 possibilities in this group (antecolic anterior, posterior and inferior and retrocolic anterior, posterior and inferior)

Side-to-side gastroduodenostomies (Fig 5) In this group the anastomotic loop may lie be-

fore or behind the transverse colon and communicate with the anterior or posterior wall of the stomach or its greater curvature and it may be combined or not with side-to-side entero-entero-anastomosis, that means that there are 12 possibilities in this group Gastric resection with antecolic anterior side-to-side gastroduodenostomy would be the correct name for the classical Billroth II operation

To sum up we find that there are 37 typical methods available for the re-establishment of gastro-intestinal continuity after resection

If in addition to performing an end-to-side, or a side-to-side gastroduodenostomy, a Y-shaped entero-entero-anastomosis is done, that would increase the methods by 12 To carry out such steps in most cases would only increase the difficulties, in some situations, however, such procedures would be found helpful

When speaking of gastric resection, partial removal of the stomach with the pylorus and antrum, or at least with the whole mucosa of the pylorus and antrum, is meant Hence the methods aiming at the re-establishment of

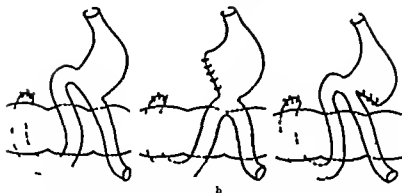


Fig. 3 Antecolic end-to-side gastrojejunostomies. a, Total (Kroenlein, Balfour) b, partial inferior (Eisenberg, Mikulicz) c, partial superior (W. Mayo)

gastric or gastro-intestinal continuity after other mutilating gastric operations (removal of the cardia, total gastrectomy, resection of the lesser curvature sleeve resection, various excisions) are not considered. The number of the aforementioned methods may be increased considerably by special technique or by peculiar circumstances.

Concerning solutions of these problems, two Hungarian examples may be mentioned.

First, Huetti constructed a special clamp for closing the stomach stump with tiny clips of aluminum-silver wire; this stomach sewing machine was simplified and modified in several ways by Pets and Donati, etc. Its use was advised in the classical Billroth II but it may be used also in partial inferior end-to-side gastrojejunostomy. Verébely cuts away the inferior corner of the closed stomach

stump and connects this opening with one made in the jejunum (Fig 9, a, b, c).

Second, in the presence of jejunal ulcer after gastro-enterostomy combined with side-to-side entero-entero-anastomosis Fischer advised connecting the stomach stump with the two limbs of the jejunal loop used for the gastro-enterostomy which are found generally adherent to each other (Fig 9 d, e). It seems much easier and better to close the two stumps of the amputated jejunal loop and aborally from them to make an end-to-side gastrojejunostomy (Fig 9 b, i).

NARROWING AND LENGTHENING THE STOMACH STUMP

Let me mention here some methods devised for narrowing the stomach stump. The methods were first advised to adjust the discrepancy



Fig. 4 Retrocolic end-to-side gastrojejunostomies. a, Total (Delagenière, Reckel, Bergmann, Pólya) b, partial inferior (Grauer, Hofmeister, Wilms, Finsterer) c, partial superior (Goetsch)

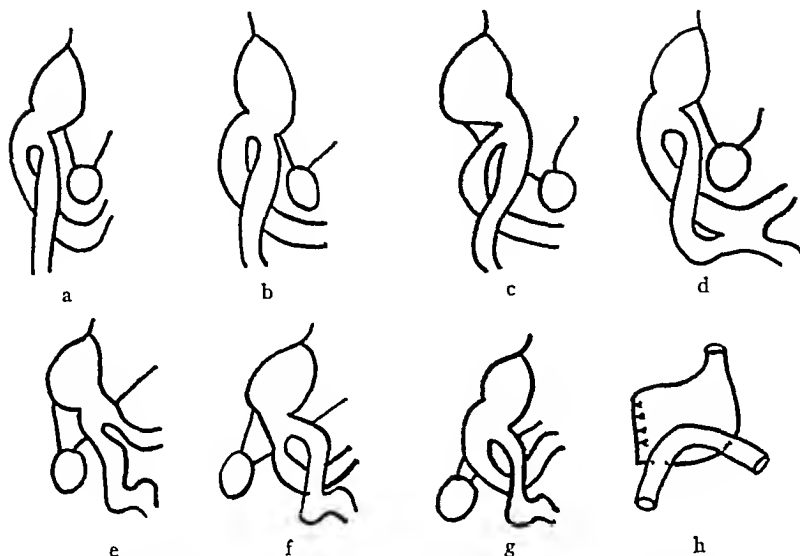


Fig 5 Side-to side gastrojejunostomies a, Antecolic anterior (typical Billroth II), b, antecolic inferior, c, antecolic posterior, d, antecolic anterior with side-to side entero-anastomosis, e, retrocolic posterior, f, retrocolic inferior, g, retrocolic anterior, h, typical Billroth II

between the lumina of the gastric and duodenal stumps before making an end-to-end gastroduodenostomy Gussenbauer and Winwarter, in 1874, in their experiments with pylorotomy on dogs cut out a wedge of the greater curvature in order to equalize the openings which were to be united (Fig 1, a) This step was followed by Rydygier and by Billroth in his first 2 gastric resections In the classical Billroth I operation the narrowing was done on the lesser curvature (Fig 1, b) Some surgeons narrowed both curvatures (Fig 1, c) and the advice to narrow the resection-line on the great curvature also returned later For example J Shelton Horsley of Richmond, Virginia, advised the alinement of stomach and duodenum at the lesser curvature and the tucking in of the superfluous lower border of the gastric stump (Fig 1, d) Haberer lessened the lumen of the stomach stump by means of a row of interrupted submucous catgut sutures In this way the narrowing of the stomach stump is distributed along the whole circumference The following 2 rows of suture help to complete this and at the end of the operation the duodenum is invaginated into the stomach and fits into it "as the stalk of the mushroom fits into its pileus" (Orator)

But it was generally along the lesser curvature that the narrowing of the stomach stump was done when the classical Billroth I operation was performed, and even in the modifications of the Billroth I the same general scheme was followed Goepel with his "Einmanschettierungsverfahren" attempted to insure the suture by forming of the stomach a cuff-like flap consisting of the gastric serosa and muscularis, which covered the suture uniting the gastric and duodenal mucosa as a cuff (*Manschette*) covers the wrist (Fig 6, c)

Shoemaker was the first, at least as far as I was able to learn, who showed the importance of lengthening the stomach stump (1910)

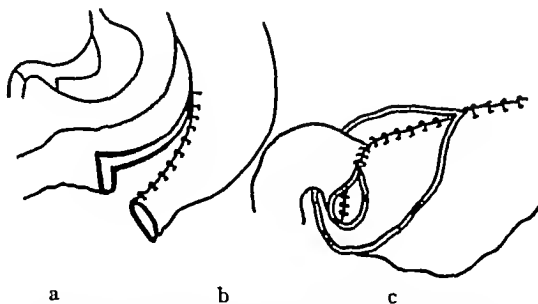


Fig 6 a, Line of incision, b, Kirschner's Schlauchresektion, c, Goepel's Einmanschettierungsverfahren

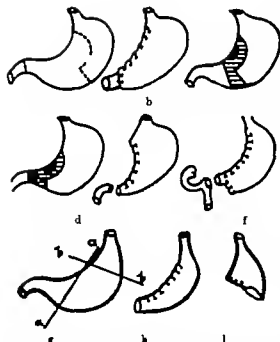


Fig 7 a, b Shoemaker's operation. a, Lines of incision b, end-to-end gastroduodenostomy. c, Schmielen's *Treppen* resection, antrectric, leaving antrum. d, the same removing antrum and pylorus. e, finished by end-to-end gastroduodenostomy. f, finished by partial superior end-to-side gastroduodenostomy. g, directions for the incision of stomach for lengthening. h, i, or shortening. h, the stump of stomach. i, lengthened stomach stump (this is the one I always use). j, shortened stomach stump.

by giving to it the shape of a tube. He calls it *Schlauch* or hose. This was done earlier also first by Graser as far as I can find but its importance at least was not emphasized. The technique used by Shoemaker which requires special clamps, is a little awkward but the kind of incision he used for shaping the stomach stump (Fig 7 a) was adopted by Schmielen in his *Treppenresection* (Fig 7 d—stair-shaped resection) and by Kirschner for his *Schlauchresection* (Fig 6 a—hose like resection). Both used this kind of stomach stump not only for gastroduodenostomy but also for end-to-side gastrojejunostomy. The method of Schmielen is founded not only on technical but also on pathological and physiological considerations. His technique aims to build up a new lesser curvature (*Magenstrasse* Waldeyer) which has some physiological importance. It eliminates the old lesser curva-

ture which plays a great part in the pathogenesis of ulcer (Aschoff). But one is able to lengthen the stomach stump in a much simpler way (Fig 7 g, a-a) and to make reliable clamping possible and thus insure asepsis.

Also with end-to-side gastrojejunostomies, in spite of the fact that before the publication of my article in 1911 such operations were done only very seldom and in quite exceptional cases and although the technique was unknown to the majority of surgeons, the fact remains that the step of narrowing the stomach stump is a very old one. It would seem that it was first done by Diehsberg¹ and Doyen.

The most important communication is that of Graser in 1906 not only because he seems to have been the first who performed retrocolic operations of this kind but also because he mentions that the stomach stump which he implanted into the jejunum was very similar to the intestine, and his illustration shows also the bowel like stomach (*darmähnlicher Magen*). The lengthening of the stomach stump is very important in the facility with which the re-establishment of the gastrointestinal continuity after gastric resection is secured (Fig 8 c).

SELECTION OF METHOD

Is there a method among all those mentioned which is preferable in all cases or shall we select a certain method for a given case and what are the criteria on which the merits of the different methods should be judged?

It is very difficult to answer these questions. Perhaps it would be better to show the dangers connected with the different types of operation for the re-establishment of gastro-intestinal continuity. The dangers arise chiefly from three factors: (a) The difference in size of the openings which are to be united by suture. (b) Undue tension on the structures which have to be brought together and (c) disturbances in the passage of gastric contents immediately or some time after operation.

As to the difference in size of the gastric and duodenal stumps, this factor was responsible for the greatest difficulties encountered

¹Remission and Gastroenterostomy, 1886, Fig. 4, b. ²Physiologie du tube digestif, 1886, Fig. 4, b.

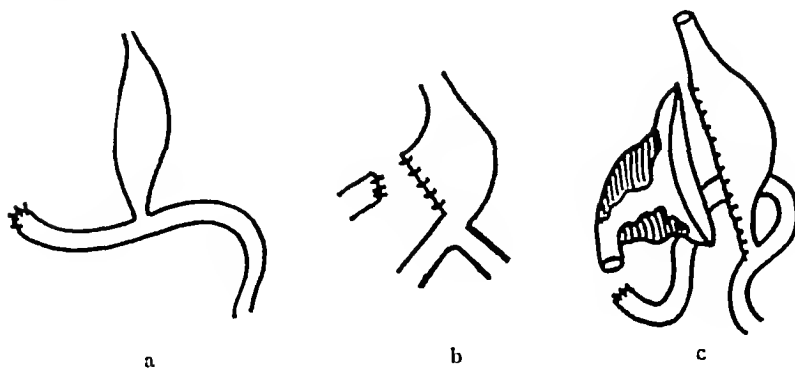


Fig 8 The first end to side gastrojejunostomies a, Kroenlein (1888) who operated for pyloric stenosis and found the duodenal stump too narrow for uniting it with the stomach and therefore implanted this in the jejunum (antecolic), b, Eiselsberg (1889) narrowed the small stomach stump which remained after the removal of a large cancer and implanted it in the jejunum (antecolic), c, Graser (1906), the first retrocolic end to side gastrojejunostomy—the remarkable lengthening of the stomach stump is the most prominent feature of this operation

in performing the original end-to-end gastroduodenostomy, the classical Billroth I operation. Attempts were made to overcome this difficulty by dilatation of the duodenal opening, by cutting it obliquely, or by a longitudinal incision in its anterior wall. The only real help was found by narrowing the opening of the stomach. Only such part of it was left open as corresponded exactly with the opening in the duodenum. The partial closure was made usually on the lesser curvature, rarely on the greater or at both, and the weak point, the *Jammerecke*, the corner of sorrow, as the Germans call it, was at the junction of the occluding linear suture of the stomach and the circular suture which united stomach and duodenum. This place, the point where the three limbs of the T or Y formed by the lines of suture met, was in especial danger, first, because of necrosis as a result of the pressure of the sutures which may impair or even destroy the blood supply of the triangle-shaped bit of tissue which lies between them, and second because of the difficulty of covering this place with serosa adequately and without undue tension.

As to the second factor, any amount of tension must be very carefully guarded against when the stomach stump is coapted with the intestine if one wishes to avoid the untimely cutting through of the sutures or even necrosis caused by forceful stretching of the

tissues. These dangers are imminent in every form of gastroduodenal anastomosis especially after extensive resections and in cases in which the mobility of the duodenum is slight or absent.

As to the third factor, disturbances in the emptying of the stomach contents, this problem must be guarded against in every form of gastro-intestinal anastomosis, but these disturbances are apt to become much more severe and generally they are also much more dangerous, when the jejunum rather than the duodenum is used for the anastomosis. And this is quite natural, because the gastroduodenal anastomosis presents nearly normal anatomical conditions for the passage of gastric contents. Swelling of the suture-line in consequence of edema or bloody infiltration, of course, may cause some transient upset in the emptying of the stomach contents as well as in producing subsequent stenosis which may become permanent. The latter occurrence is very rare when proper technique is used. After resections, however, which are completed by a gastrojejunostomy there may threaten all the disturbances which may arise after a gastrojejunostomy without previous resection: kinks especially, though rarely other forms of mechanical obstruction, may occur in the vicinity of the anastomosis immediately after the operation, and jejunal ulcers and their sequels may develop later. It is true

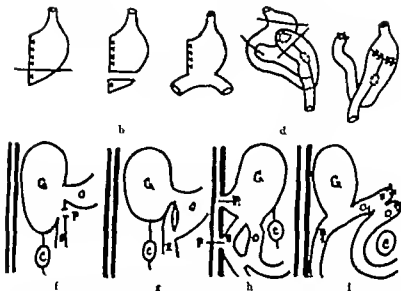


Fig. 9. a, b, c, "Corner-anastomosis" of Verheij. a, Closed stomach stump, b, corner of the great curve cut off, c, stomach stump implanted in the jejunum, d, e, Fischer's operation, d, gastro-enterostomy and entero-entero-anastomosis (dotted lines) and lines of resection, e, stomach together with the opening of gastro-entero-anastomosis and the top of the anastomotic loop removed, gastric passage restored, f, jejunal ulcer after retrocolic posterior gastro-enterostomy perforated, g, restoring of gastric passage by side-to-side entero-entero-anastomosis, the efferent loop being stenosed by the suture of the perforated ulcer, h, antecolic anterior gastro-enterostomy with side-to-side entero-anastomosis, stomach, G, in the neighborhood of gastro-enterostomy and efferent loop, E, between the openings of the gastro-enterostomy and entero-entero-anastomosis into the anterior abdominal wall perforated, P, C, transverse colon, O, efferent loop, l, Condition after operation, resection of stomach together with the stenosed efferent loop and the opening of gastro-enterostomy, afferent and efferent loops closed, entero-entero-anastomosis left, stomach stump implanted in the jejunum below the entero-entero-anastomosis, E, efferent, O, afferent loops of the end-to-side gastrojejunostomy.

that one important source of trouble in the passage of stomach contents after the ordinary gastro-enterostomy namely the patency of the pylorus, is eliminated by gastric resection but if the pylorus is occluded the consequences are much worse than those which happen after an ordinary gastro-enterostomy.

If after gastro-enterostomy the contents of the stomach cannot leave it by the efferent loop they regurgitate by the afferent loop and pass through the more or less open pylorus back into the stomach. But if there is no pylorus at all the contents stagnate in the duodenum fill it, dilate it, and augment by stagnation in it because the dilated duodenum is less able to expel its contents than the normal for the muscles are stretched and at the same time have a more difficult task to

perform. Under these circumstances when the contents of the stomach and the afferent loop cannot pass into the efferent loop (Fig. 10, b) or by the efferent loop (Fig. 10, a) the duodenum can empty only into the stomach and eventually its contents may be removed by vomiting. It is still better that the patient vomit than to have fluid remain stagnant in the duodenum, because the pressure of the dilated duodenum on the solar plexus may produce very serious and even fatal symptoms or it may cause insufficiency and perforation of the suture occluding the duodenal stump.

The situation is still more serious if a kink is located at the entrance of the afferent loop to the anastomosis (Fig. 10, c). Such a condition may entirely prevent the emptying of duodenal contents. It is true the duodenal

contents is composed chiefly of bile and pancreatic juice, but occlusion of the duodenum always causes a hypersecretion of these, so there may arise a vast accumulation of fluid in the duodenum, which cannot pass by any means out of the duodenum because its oral end is closed by the suture, its aboral by the kink. This condition may lead to rapid collapse and death, or may cause perforation of the duodenal stump into the peritoneal cavity.

This complication, a kink at entrance of afferent loop to the anastomosis, threatens especially in cases in which the stump of the stomach is too small and the small intestine has to be drawn highly upward for the anastomosis. Also there are some technical failures, for instance, faulty fixation of the mesocolic slit to the small intestine may produce it. It can certainly be avoided by an entero-entero-anastomosis between the two limbs of the anastomotic loop and therefore it is always wise to make this (preferably a small loop) as a safety-valve when the stomach stump is too small. However, especially in ulcer-cases the combination of gastrojejunostomy with entero-entero-anastomosis is not always harmless, it may help to produce a jejunal ulcer later.

Jejunal ulcer, the other serious complication which may follow gastrojejunostomy, is much less likely to occur when resection is done, than when resection has not been done and the patient has his entire stomach. It may occur nevertheless after resection, and in such cases it is much more difficult to deal with than when resection has not previously been done. The only sure means of avoiding jejunal ulcer is to keep the jejunal mucosa out of direct contact with the gastric juice, and that can be done only by gastroduodenostomy.

POINTS OF ADVANTAGE

There are two more points which deserve careful consideration: the ease with which the operation can be performed and the function of the stomach after different kinds of operations.

Ease in operating is chiefly dependent on the possibility of performing the operation outside of the abdominal cavity. The more one is able to do that, the easier the operation

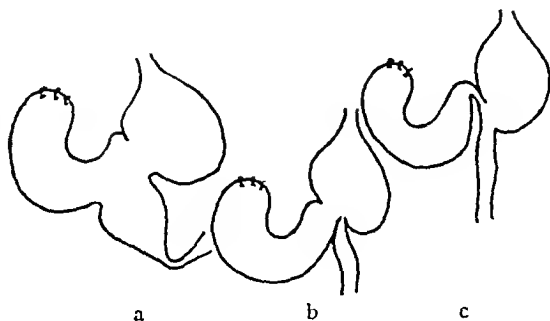


Fig. 10. Difficulties in passage of gastric contents after resection: a, Kink of the efferent loop, b, kink at the beginning of the efferent loop, c, kink at the end of the afferent loop.

and the surer the asepsis, also it facilitates the process of suturing and makes possible the minute control of the sutures. In addition time is saved and this helps to avoid collapse, pneumonia, and other complications which may endanger the patient's life after operation. In this respect a gastrojejunostomy is generally superior to a gastroduodenal anastomosis, but not in all cases, and in many the difference may be eliminated. Regarding function, it is evident that the gastric passage re-established after a gastroduodenal anastomosis more closely resembles normal anatomy than when a gastrojejunostomy has been made. Function is impaired after both, but it seems to be less so after gastroduodenostomy than after gastrojejunostomy. The functional value of any resected stomach is greatly diminished, removal of the pylorus deprives the stomach of the power to keep back its contents until satisfactorily prepared for digestion in the intestine, the removal of a considerable part of the musculature of the stomach impairs its contractile power so that its faculty to expel its contents by its own force is lost and the mixing, grinding, and triturating activities are quite impossible. Resection also abolishes the so called second, or chemical phase, of the secretion of gastric juice. The resulting hypacidity may be augmented or replaced by complete anacidity brought about by too extensive ablation of the secretory surface and by the reflux of bile and pancreatic juice, which may occur also through gastroduodenal anastomoses but generally is much more copious if

a gastrojejunostomy is present. Enderlen, Freudenberg and v. Redwitz showed that in the latter instance there is a possibility only of tryptic digestion in the resected stomach whereas in the former the acidity is too low for peptic digestion but not low enough to permit tryptic digestion. This circumstance is of secondary importance because intestinal digestion can take the place of the missing gastric digestion. Therefore the majority of patients feel perfectly well and gain weight after gastric resection. The chief cause of trouble if there is any trouble at all is the too rapid or too slow emptying of the resected stomach. As to the first, some patients feel permanently hungry, may be awakened by it at night. In the second instance, some patients feel a disagreeable fullness and heaviness after meals, sometimes even after a few mouthfuls and this distress may last for hours and may end with vomiting. The too rapid emptying (*Sturzentleerung*) of the stomach is typically peculiar to too broad gastrojejunostomies especially when the opening of the stump of the stomach is not narrowed before it is implanted into the jejunum. This condition is noted particularly soon after operation but later it may improve. The very slow emptying of the stomach may be caused by stenosis of the anastomotic opening by ulcerous stricture of the duodenum or the efferent loop of the small intestine or by shrinkage of adhesions. But also spastic contractions of the duodenum especially at the terminal part of the bulb (Goetze) or of the small intestine (Schur) may hinder the propulsion of the gastric contents. The greater the amount of stomach removed the less will be the contractile power of the remaining stomach, the greater the part hydrostatic pressure will play in the emptying of the stomach, the greater will be the significance of the resistance the intestine may exercise against the progression of gastric contents.

Generally the patients with gastroduodenostomies present more favorable conditions than do those with gastrojejunostomies as far as continence as well as secretory activity is concerned. As to the gastrojejunostomies, functions of the retrocolic types and of those types with not too large openings are generally better.

Summing up the conditions created in gastroduodenostomy come nearer meeting the physiological standard. This is borne out by clinical experience on the whole after gastric resection with gastroduodenostomy patients complain less than do patients who have had a gastrojejunostomy, also they are less liable to late complications than the latter. On the other hand, gastrojejunostomies are generally easier and safer to perform.

TECHNICAL DIFFICULTIES

The technical difficulties encountered in doing a gastroduodenostomy are due chiefly to the immobility of the duodenum. This varies in different cases. In certain cancer cases, especially in thin people with ptotic stomach, the upper transverse portion of the duodenum is often very much elongated. In such patients the coaptation of the gastric and duodenal stumps is generally very easy. In the presence of duodenal ulcer however the duodenum is usually quite immovable, very often it is embedded in hard adhesions especially when the ulcer is on the posterior wall and penetrates into the pancreas. In such a case the duodenum can never be mobilized sufficiently to be used for end-to-end gastroduodenostomy. But there are cases in which the duodenum is not fixed by strong adhesions but only by such as are easily divided. Other times it is quite free but too short to be brought in contact with a not very large stomach stump. In such cases Kocher advised mobilization of the duodenum. Generally it is much simpler and easier to lengthen the stump of the stomach. The difference in size of the openings must be adjusted in any case and this may be accomplished in a way which helps to coapt the duodenum with the stomach. If the stump of the stomach is cut and sewed in the proper way it becomes a cylindrical structure a tube very similar to the small intestine, thus the difficulties in gastroduodenal suture are reduced to those of a circular intestinal suture. And if one uses this tube like stomach stump for the gastroduodenal suture after the through-and-through and serosal sutures partially closing the stomach stump are perfectly completed, then the much dreaded place of

meeting of the two suture lines loses all its perilousness. Two structures entirely covered with serosa are to be united, therefore, there is no danger provided union can be accomplished without any tension and this is generally possible when the gastric stump is prepared in the proper manner.

When properly done, therefore, the gastroduodenal suture is not only as easy as the circular suture of the small intestine, but it is likewise as safe, safer indeed because there is no mesenteric border where the covering with serosa is imperfect. Thus the *Jammerecke* is completely eliminated.

And not only for the end-to-end gastroduodenostomy, but also for every other form of gastro-intestinal anastomosis in which the opening of the stump of the resected stomach is to be united with or implanted into the wall of the intestine—this tube-like form of the stomach stump has many advantages because

First, its length (1) relieves the tension and facilitates coaptation as well as the placing of the sutures, (2) makes room so that soft clamps may be applied and in this way asepsis is promoted, (3) helps asepsis in that it is possible to do the suturing outside of the abdomen thus making perfect isolation feasible.

Second, narrowing the lumen—not only makes suturing easier by reducing the gastric lumen, but also favors later function—for the rapidity of the evacuation of the stomach stump is diminished.

Third, the chief advantage, however, is the perfect covering with serosa. This insures safety in the suture, the weak points, for instance, the fat and the ligated blood vessels of the lesser curvature, may be not only covered with serosa, but are far from the line of the circular suture. The longitudinal occluding suture line of the stomach already covered with serosa causes no difficulty whatever in making the circular suture. If done properly, the two suture lines do not weaken each other; on the contrary, they are made stronger by covering each other with a new layer of serosa.

THE TUBE-LIKE FORM OF STOMACH STUMP

The tube-like form of the stomach stump is certainly the most useful, therefore, it is

wise to fashion it into this shape in every case in which one has to re-establish gastro-intestinal continuity after gastric resection. There are of course some exceptions, for instance, in secondary resections when a gastro-enterostomy has previously been made, and when one must remove only that part of the stomach which lies between the duodenum (pylorus) and the gastro-enterostomy and then close the lines of resection.

Of the aforementioned forms of the gastro-intestinal anastomosis I prefer *end-to-end gastroduodenostomy*, if this is not feasible because of the condition of the duodenum, I prefer retrocolic partial inferior end-to-side gastrojejunostomy. Which of the two is to be chosen is often quite evident at first inspection after the opening of the abdominal cavity, but sometimes a decision is reached only after the removal of the diseased part of the stomach.

The advantages of gastroduodenostomy over the gastrojejunostomy have already been discussed. One purely technical point may be added. Stomach and duodenum lie in the so called upper story (*etage*) of the peritoneal cavity, which is well separated from the lower and much larger section by the transverse colon and mesocolon. Gastroduodenostomy is of value if in the course of an abdominal operation one is able to limit it to a strictly circumscribed area which can be perfectly isolated during and after the operation. If a gastroduodenostomy is made, one avoids tampering with the small intestine, in fact one need not even see one loop of it. For this reason the danger of postoperative adhesions, which may cause very disagreeable complications immediately as well as eventually, months and years after operations, is diminished. By all means it is always wise to limit the field of operation, unless other important considerations require the contrary. Here again is a point in favor of gastroduodenostomy if it is feasible and safe in a given case. Another point in its favor is that occlusion of the mesocolic rent, which has some awkward features, is avoided with gastroduodenostomy.

As already mentioned, it is chiefly the condition of the duodenum, especially if a duodenal ulcer is present, which makes it impossible to perform an end-to-end gastroduo-



Fig. 1



Fig. 2



Fig. 3



Fig. 4

Fig. 1. First step in partial occlusion and lengthening of the stomach stump. Temporary occlusion of the upper part of the resection line of stomach by mattress suture.

Fig. 2. Second step in partial occlusion and lengthening of the stomach stump. Removal of the fenestrated clamp; the artery clamps ensure against the retracting of the stomach wound, generally they are not necessary if omentum is fast enough, the crushed edges of the stomach sticking to each other.

Fig. 3. Third step in partial occlusion and lengthening of the stomach stump. Definitive partial occlusion of the stomach wound by suture which goes through its whole thickness, it is better if lockstitch sutures be used instead of simple continuous sutures.

Fig. 4. Fourth step in partial occlusion and lengthening of the stomach stump. Seroserosal sutures covering the through-and-through sutures. The first stitches fasten the serosa in proper place.

denostomy. If we cannot secure a circular well nourished, movable tube of duodenum at least 2 centimeters long it is better to desist from it. While in certain cases the line of resection of the duodenum is manifestly useless for circular suture it is found that the section of duodenum which lies behind the duodenal ulcer or scar is broad, easily accessible and covered with healthy serosa and measures in length at least 5 to 6 centimeters. In such cases it is preferable to make an end-to-side gastroduodenostomy for the gastric stump can always be shaped to the most convenient form in cases of duodenal ulcer.

Except in these cases which are very few indeed in all other cases in which the end-to-end gastroduodenostomy cannot be performed, the retrocolic end-to-side gastrojejunostomy with a tube-shaped stomach stump is the operation of choice. The retrocolic method

is to be preferred to the antecolic because it creates better conditions for the undisturbed passage of gastric contents and presents less possibilities for intestinal obstruction. It is true that antecolic gastro-enterostomy is easier to perform and that its failures are generally easier to be remedied than are those after retrocolic operation. Such failures, however are more frequent and more inevitable with antecolic than with retrocolic anastomoses—if they are properly performed. The remedy for the failures of gastrojejunostomy—jejunojunal anastomosis—particularly in ulcer cases is not without danger to the future welfare of the patient. Therefore it is better to avoid it if at all possible. The only situation in which one must not fear an entero-entero-anastomosis and in which it should always be done is the presence of a very small stomach stump which is supposed not to produce sufficient



Fig 15

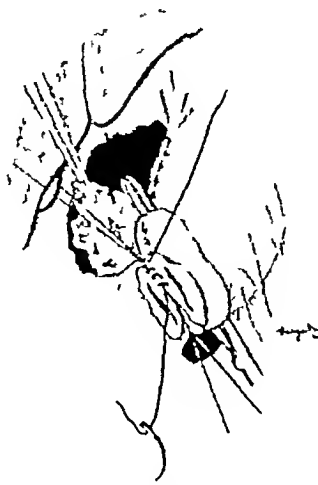


Fig 16



Fig 17

Fig 15 First step in end to end gastroduodenostomy The first serosa stitches are in place, uniting stomach stump and duodenum, they are laid on a tag of omentum At the operation there is of course a strip of gauze between them, until the anterior row of through and through sutures is finished

Fig 16 Second step in end to end gastroduodenostomy The artery clamps occluding the stumps are taken away and the posterior row of through and through sutures is begun

Fig 17 Third step in end to end gastroduodenostomy The anterior row of seroserosal suture

Fig 18 Fourth step in end to end gastroduodenostomy The anterior portion of the seroserosal suture is covered with the omental tag



Fig 18

hydrochloric acid as to cause an ulcer In such cases the antecolic operation also has the advantage that the difficulties of closing the mesocolic rent are eliminated and in cases of highly situated, small stomach stumps such difficulties may be very great indeed

Antecolic anastomosis may be preferable, too, when adhesions or other anatomical changes around the first jejunal loop present difficulties for instance when the resection is done for jejunal ulcer, whereas adhesions of the stomach and mesocolon are to be severed in any case if the former is to be resected, except in very rare instances when the transverse colon must be removed as well

In certain cases if the stomach is not dilated and the cross section of it is exceptionally small, its stump may be directly implanted unnarrowed in the jejunum In the most cases, however, a tube-shaped stump is far better

FORMING THE GASTRIC STUMP

The technique of properly forming the gastric stump is quite simple The stomach is cut obliquely from left to right and from above downward (Fig 7, g a) In this way more of the lesser curvature is removed than of the greater one This is generally desirable in cases of gastric cancers and in gastric ulcers

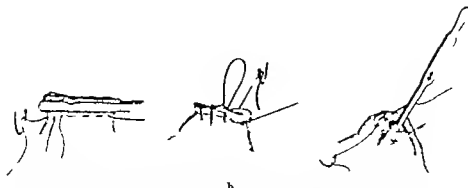


Fig. 9. Closing of the duodenal stump. a, Temporary closure by through-and-through mattress-suture. b, final through-and-through continuous suture by drawing together the thread the stump is doubled. c, tucking in the stump and covering it with serosa.

as well because an affection on the lesser curvature is usually more extended than on the greater one. In the presence of duodenal ulcer however it is indifferent. The obliquity of the line of resection must certainly not be exaggerated. The cutting is done between two hard clamps. On the oral side I prefer to use a fenestrated clamp (Graser's). Through its middle slit I apply a continuous mattress-suture with catgut going through both walls of the stomach and keeping them temporarily together (Fig. 11). The suture begins at the lesser curvature and ends 3 to 5 centimeters over the greater curvature. The beginning of the thread is left long and armed with a second needle. The opening of the stomach should be left somewhat wider when end-to-side gastrojejunostomy is intended than when gastroduodenostomy is to be made.

When the part which is to be occluded is temporarily fixed by this thread a soft clamp is put on 3 to 5 centimeters behind the hard clamp and the latter taken away (Fig. 12) the unstitched part of the stomach wound, which was crushed by the clamp is grasped by a narrower clamp. I generally use Kocher's artery forceps. The tip of this should be at the point where the last stitch of the mattress-suture emerges from the stomach. During this time the assistant holds the line of resection by stretching the thread. Now while he keeps tense the end of the thread which lies nearest to the greater curvature one unites the stomach wound with the needle left on the begin-

ning of the thread by continuous through and-through suture (Fig. 13) until one reaches the end of the mattress-suture and ties both ends of the thread together. After this, the soft clamp is removed. It is advisable to accomplish the occlusion of the stomach stump by lockstitch sutures in order to prevent bleeding quite surely.

Then this occluding suture is covered with serosa (Fig. 14). I prefer for this interrupted sutures the last of them put on immediately over the tip of the occluding artery forceps. One must take broad serous surfaces to cover quite securely the through and through suture at the oral end this serosa-suture must overreach the end of the through-and-through suture by 2 to 3 centimeters. If feasible without any tension, even the ligated stumps of the vessels of the lesser curvature should be turned in and the serosa-suture continued to this point.

END-TO-END GASTRODUODENOSTOMY

End-to-end gastroduodenostomy requires that the end of the elongated tube-like stomach stump and the free part of the duodenum be easily brought together also it must be possible to coapt 2 to 3 centimeters of them without any tension. This point must be definitely assured before one decides finally to make the end-to-end gastroduodenostomy bringing in contact the stumps of the stomach and the duodenum which is likewise held by a Kocher artery forceps. Before the suture is



Fig 20



Fig 21



Fig 22

Fig 20 First step in end to side gastroduodenostomy The stomach stump is being brought toward the closed duodenal stump

Fig 21 Second step in end to side gastroduodenostomy The first stitches of the posterior row of serosa sutures

Fig 22 Third step in end to side gastroduodenostomy Opening of the duodenum

Fig 23 Fourth step in end to side gastrojejunostomy The serous suture is finished



Fig 23

started it is wise to look for a long tag of omentum. The tip of this caught with an artery-forceps is brought upward and laid below the meeting-place of the stomach and the duodenum to be united. It should be isolated by a thin strip of gauze. Now the stumps of the stomach and the duodenum occluded by Kocher forceps are laid over this and the uppermost serous stitch made (Fig 15). It should go 1.5 centimeters above the last stitch of the occluding linear serous suture of the stomach and 1 to 1.5 centimeters behind the artery forceps occluding the end of the duodenum at its upper border. This stitch is tied whereas the stitch which unites the inferior border of the duodenum with the greater curvature 1 to 1.5 centimeters behind the Kocher

forceps is not tied although it is inserted when the posterior row of the seroserosus suture is begun. Now the posterior surfaces of the gastric and duodenal stumps are united with interrupted Lembert sutures, beginning at the lesser curvature and continuing to the greater curvature until the last suture, which was left loose, is reached. Then this is tied likewise. Now a soft clamp is put on the stomach 3 to 5 centimeters behind the suture line and after careful isolation the Kocher forceps are removed, and the full thickness of the edges of the gastric and duodenal stump is sewed together with continuous catgut suture from the inside as far as possible (Fig 16). Generally this is easily possible for at least three-fourths of the suture line. One begins at the lesser



Fig. 24



Fig. 25



Fig. 26



Fig. 27

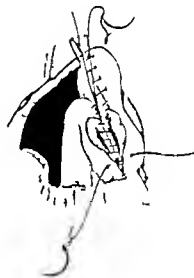


Fig. 28

Fig. 24. First step in end-to-side gastrojejunostomy, partial inferior. The first stitches in the posterior row of the serosal sutures to unite jejunum and stomach stump are shown.

Fig. 25. Second step in end-to-side gastrojejunostomy. Opening of the jejunum.

Fig. 26. Third step in end-to-side gastrojejunostomy. The posterior row of the through-and-through sutures uniting stomach and jejunum are shown. Lock stitches are better but the drawing seemed clearer with simple continuous suture.

Fig. 27. Fourth step in end-to-side gastrojejunostomy. The posterior row of the through-and-through sutures is finished. The stitch uniting the greater curvature to the

jejunum, which is left long and pulled by the assistant to coapt the edges of the anastomosis of the stomach and jejunum, is cut short. Another stitch, which penetrates the hole thickness of stomach and jejunum is put in at distance of 1 to 2 centimeters from the above mentioned stitch. This is tied, kept stretched by the assistant, and the continuous suture is continued from end.

Fig. 28. Fifth step in end-to-side gastrojejunostomy. The suture from inside is finished after the end of the thread is tied to the last interrupted stitch. Immediately over it, a stitch is placed from the outside, which turns in the mucosa. This is tied, left long, and given to the assistant to pull. The upper end of the thread of the continuous suture which is left long is armed with needle.



Fig 29



Fig 30



Fig 31



Fig 32



Fig 33

Fig 29 Sixth step in end to side gastrojejunostomy. The anterior row of the through and through suture is continued from outside the mucosa and being turned in the serosal surfaces co-apted.

Fig 30 Seventh step in end to side gastrojejunostomy. The soft clamp is removed just before finishing the anterior row of through and through sutures. One or two interrupted sutures were inserted earlier to secure right co-aptation of the wound in the middle of the wound or on both ends of its middle third.

Fig 31 Eighth step in end to side gastrojejunostomy. The first and last serosal stitches which were left long until now are cut short and covered with new serosal stitches. Other interrupted serosal stitches are put in if necessary to coapt the serosa exactly.

Fig 32 Ninth step in end to side gastrojejunostomy. After this continuous suture, the anterior row of sutures is finished.

Fig 33 Tenth step. The mesocolic rent is stitched to the stomach with a few interrupted sutures.

curvature leaving the thread long at the beginning and placing the suture on the inside carefully co-apting the margins of the wounds of the mucosa. If a stitch is previously placed at the site of the greater curvature the suturing is facilitated (see Fig 26). When one reaches this stitch another is put in 2 or 3

centimeters farther, from the inside (Fig 27). This is tied, and the assistant pulling on it turns out the mucosa, and the continuous suture is started. If the suture from the inside cannot be further continued, the end of the thread of the continuous suture is tied to the last stitch, cut short, and the mucosa is turned

in again. Now a through going stitch is inserted at this point and tied from the outside (see Fig. 18). The beginning of the thread which was left long is armed with a needle and the remaining gap is closed with through going continuous suture (see Fig. 19) until the last stitch is reached and tied. Shortly before this the soft clamp must be removed (see Fig. 30). After this the seroserosus suture is completed on the anterior wall (Fig. 17) preferably with interrupted sutures. One or two seroserosus sutures are placed above and below the last stitches of the posterior seroserosus row which had been left long and they are covered after cutting with one or two Lembert stitches. When the seroserosus suture is finished the tag of omentum which already covers the posterior surface of the suture is placed on the anterior surface as well (Fig. 18). In this way the whole suture is packed in omentum. To fix this omental tag by suture is quite unnecessary. It covers the suture abundantly and does not move from its place if not pulled down forcibly.

END-TO-SIDE GASTRODUODENOSTOMY

End-to-side duodenogastrostomy (Kocher's operation) was the method I preferred when a beginner. However it involves mobilization of duodenum, and although generally very simple and quite bloodless, at times may be followed by bleeding from small vessels, and, being retroperitoneal, is never unimportant and may be quite disagreeable. The form of the stomach stump is also not always suitable for the Kocher operation. One may do a Billroth I easily in cases in which the Kocher operation is quite impracticable. The occluding suture of the stomach is also a factor as it takes time quite unnecessarily. I therefore discarded this method entirely. But in some cases already described end-to-side gastroduodenostomy (Finney-Haberer) may be preferable. If one wishes to attempt this method it is advisable to save as much as possible of the duodenum, preferably the whole—and therefore leave the diseased part of the duodenum untouched and do the resection on the gastric side of the pylorus. The small funnel of gastric mucosa remaining is excised, and the muscularis is closed and covered with

serosa. The properly prepared stomach stump the end of which is held by a Kocher artery forceps is now placed on the anterior surface of the already closed duodenum (Figs. 19 and 20) the occluding suture of the stomach to the right and upward the greater curvature to the left and downward at least 1 to 2 centimeters from the occluding duodenal suture. At each of these points one seroserosus stitch is inserted and tied (Fig. 21). The partial occluding suture of the stomach is applied as near to the upper border of the duodenum as possible and between them a whole row of interrupted Lembert sutures to complete the posterior serosal suture now a soft clamp is placed on the stomach stump as far as possible from the suture-line the duodenum is incised parallel to the opening of the stomach and as far as possible in the longitudinal axis of the duodenum which corresponds here to the transverse axis of the body. The incision is $\frac{3}{4}$ centimeter underneath the serosal suture and is somewhat shorter than the gastric wound. The artery forceps, which is occluding the stomach stump (Fig. 22) is now removed. The wounds are sutured with catgut through-and-through continuous sutures, as far as possible from the inside. When the through-and-through suture is completed and the soft clamps are taken off the suture as well as the last serosal stitches of the posterior row which were left long and only now cut is covered with serosa (Fig. 23) continuous or interrupted as it seems safer and handier. The whole is then covered with omentum.

END-TO-SIDE GASTROJEJUNOSTOMY

If end-to-side gastrojejunostomy should be performed, the stomach stump is first prepared and then the duodenal wound is closed by ligating or sewing and turning in the stump and covering it with at least two rows of serosa the second of which may unite the anterior surface of the duodenum with the pancreas.

In the presence of duodenal ulcer when the dissection of the duodenum or its reliable covering with serosa seems difficult or even dangerous or impossible the reaction should be done rather at the gastric side of the

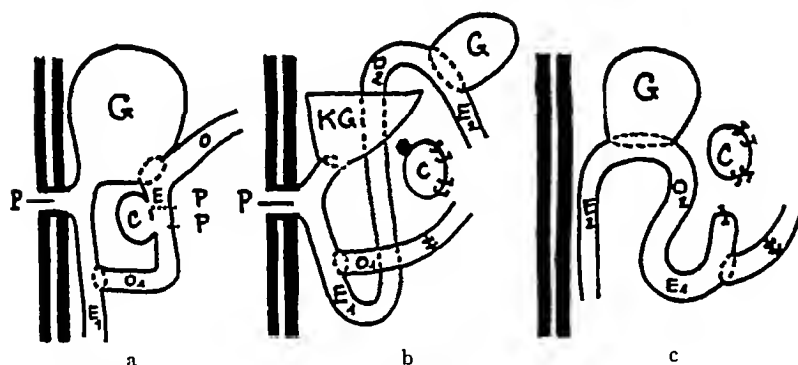


Fig 34 a, The condition present in a 39 year old man who had already had five stomach operations done by as many different surgeons. There was a retrocolic posterior and an antecolic Y shaped gastro-enterostomy. The jejunal ulcer which developed at the site of the posterior anastomosis had 3 perforations—two in the colon, one to the anterior abdominal wall (this last one is not depicted in the drawing) at the efferent loop of the Y-shaped anastomosis, one jejunal ulcer breaking through the abdominal wall and producing there a fistula. b, Condition after the first operation excluding the part of the stomach which contained the anterior gastro-enterostomy, the posterior gastro enterostomy was disconnected, the openings of the transverse colon closed, the stump of the stomach implanted into the jejunum below the entero-entero-anastomosis, which appertained to the V shaped gastro-enterostomy. c, The second operation removed the excluded part of the stomach with the anterior gastro-enterostomy and its efferent loop. G, Stomach, KG, excluded stomach, C, transverse colon, P, perforation, O, afferent, E efferent loop of the retrocolic gastro-enterostomy, O₁, afferent, E₁, efferent loop of the Y shaped gastro-enterostomy, O₂, afferent, E₂, efferent loop of the end to side gastrojejunostomy

pylorus, and this wound should be closed as described

Chiefly 3 points must be remembered here (1) the friability of the duodenal wall which may be such that every suture cuts through, (2) the rigidity which may make its tucking in quite impossible, (3) the close proximity to the common duct which in cases with duodenal ulcers may lie surprisingly near the pylorus and may subsequently be injured by the dissection or by the suture

After the duodenal stump is closed, gloves and isolating material are changed, the transverse colon is lifted, drawn upward, and the first loop of the jejunum is sought and brought through a longitudinal incision in the bloodless part of the transverse mesocolon in the operating field. Then the transverse colon and the omentum are put back into the abdomen. One must determine very exactly the site and direction of the first jejunal loop, which is used for the anastomosis, so that every kink or torsion of it be surely avoided. It is best to take the part of the jejunum which lies 10 to 12 centimeters below the plica duodeno-

jejunalis for the anastomosis. Here, in the vicinity of the left mesenteric border, should be placed the first stitch which fixes to the jejunum the occluding suture line of the stomach about 1 to 1.5 centimeters behind the occluding Kocher forceps. The occluding suture of the stomach is laid nearest to the plica. Then the last stitch of the posterior serous row, which fixes the greater curvature to the mesenteric border of the jejunum, is inserted (Fig 24) and between the two the posterior serosal row of sutures is completed. It is best to use interrupted sutures and to take care not to injure the great vessels which lie here under the serosa of the jejunum. Then a soft clamp is placed on the stomach, the incision of the jejunum is made (Fig 25) in its longitudinal axis about $\frac{1}{2}$ – $\frac{3}{4}$ centimeter from the posterior serosal suture (to clamp the jejunum is superfluous) and somewhat shorter than the wound of the stomach. Then a catgut through-and-through suture unites the jejunum with the stomach, as much of it as possible being done from the inside and with continuous sutures (Figs 26 to 29). The soft

clamp is taken off shortly before this through and through suture is completed (Fig. 30) and after this row of sutures is completed the anterior row of seroserous suture is made as described (Figs. 31 and 32). One makes sure by invaginating the wall of the efferent loop with the index finger that the anastomosis is quite permeable. Then lifting the transverse colon again one returns the jejunum to its place again makes sure that there is no kink or torsion, or any other irregularity and finally sews the rent in the mesocolon to the stomach wall about 1 to 2 centimeters away from the suture line (Fig. 33). It is not good to sew it to the suture line and still worse to sew it to the jejunum.

The gastrojejunal suture line lies below the transverse mesocolon. In the cavity which remains over the transverse colon and mesocolon it is well to put omentum to cover the occluding gastric suture as well as the duodenal stump.

ANTECOLIC END-TO-SIDE GASTROJEJUNOSTOMY

If the stomach stump is too small antecolic end-to-side gastrojejunostomy with side-to-side jejunojejunal anastomosis is the safest method as already mentioned. The best place in the jejunum for antecolic gastric anastomosis lies 30 to 50 centimeters from the duodenojejunal fold. The anastomotic loop by no means should be too short because this would predispose to its compression by the transverse colon as well as to kinks. Jejunojejunal anastomosis is best made at a point where the two loops can be brought the most easily together generally about a hand's breadth below the gastro-enterostomy. Other technical details are identical with those already described. One must take care to avoid torsion and the creation of pouches which

may cause earlier or later intestinal obstruction. Also there are cases which require special measures. Figure 34 shows a case of mine with two gastro-enterostomies and 4 perforations due to jejunal ulcers, two into the colon and two into the anterior abdominal wall. One of the latter developed a broad fistula, through which intestinal contents copiously flowed out. In this case I operated in two stages. At the first operation I disconnected the posterior gastro-enterostomy, closed the colic fistulas, and after dividing the stomach transversely and implanting its oral part into the jejunum closed and excluded its aboral section which still contained the anterior gastro-enterostomy. In the second operation I extirpated the excluded part of the stomach and removed the fistulous small intestine connected with it, closing the stumps of the duodenum and the jejunum. Figure 9, f and g shows on the other hand a very simple method for restoring the gastro-intestinal continuity after perforation of a jejunal ulcer into the free abdominal cavity. The method is especially useful when the presence of pyloric stenosis makes restoration by simple disconnection of the gastrojejunostomy impossible and when at the moment resection is at least inadvisable. The perforation is sutured and if this causes stenosis of the efferent loop entero-entero-anastomosis between the efferent loop (below the stenosis of course) and the afferent loop re-establishes passage. Later a resection may be done in the manner shown in Figure 9, h and i.

Many other peculiarities may be met making other procedures advisable—many roads lead to Rome and circumstances must guide us in choosing the best method. Sometimes it may prove a difficult problem to find the right one.

OPERABILITY AND FACTORS THAT INCREASE CURABILITY OF CARCINOMA OF THE RECTUM

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WHEN the diagnosis of rectal cancer has been made, the problem that next confronts the surgeon is the question of operability. Operability factors include age, general condition of the patient, extent and fixation of the local process and, finally, metastases to distant parts. Operability is variously quoted even in recent literature as ranging between 30 and 70 per cent. These facts must cause considerable confusion to the reader. Until we adopt some simple plan and method of calculating our statistics on operability, they will be meaningless and uninteresting figures because one cannot compare his own work with that of others and see where he stands. Comparison is instructive and inspires all of us to better accomplishments. When one sees surgeons of equal capabilities having a variance of from 30 to 70 per cent in operability figures, it means that they have entirely different methods of analyzing their statistics. If we are in earnest about gathering statistics of value as to the sanest and safest way to cope with the problem of carcinoma of the rectum, it seems to me that we can do it very simply because here, at least, we speak the same language.

Generally speaking, the lower the operability rate the higher the curability rate, because one usually takes for radical operation only the early cases, and does palliative operations on the doubtful or advanced cases. This may or may not be true, but it could be ascertained if all the facts were presented. Pertaining to this very point, I may say that Miles, of London, quotes an operability of 30 per cent. Not long ago while conversing with him on the subject, he made the statement that he meant he operated on 1 out of every 3 patients he saw and he counted them all. When one considers his leadership in this field and the fact

that he has had a large service at the Cancer Hospital where many derelicts are sent, his operability would be 60 or 70 per cent as compared on an equal basis with that of others.

There are various operability factors to be analyzed. Many writers in the past have automatically set an age limit at 60 or 65 years but, after all, age in number of years does not tell the whole story. Many a man at 70 may be a better risk than a man at 60. While his life expectancy may not be as long, we cannot stand by and do nothing on account of age alone. The prolonged, terminal suffering of these individuals is a challenge to the surgeon to fulfill his obligation to the utmost.

Several months ago I was confronted with the problem of a man 73 years of age with a very doubtful operable carcinoma of the upper rectum, completely fixed to the seminal vesicles and the peritoneum at the rectovesical pouch. A combination of factors, namely, a lean, wiry type of individual otherwise in good health, with no obvious metastases, and a request to be given every possible chance, led me to proceed with the operation. A combined abdominoperineal operation in one stage, including the seminal vesicles in one mass, was performed. He made an uneventful recovery and left the hospital on the seventeenth day. In a very obese man even at 60 years of age this might not have been very good judgment. Experience frequently lends a guiding hand.

Location and fixation. This has a bearing on operability. Generally speaking, we consider a growth on the anterior wall in proximity to the bladder, seminal vesicles, and urethra as more difficult than one on the posterior wall especially if attended with fixation. Considerable fixation on the posterior wall may be removed more easily than moderate fixation anteriorly. It is frequently impossible to estimate whether fixation is due to inflammatory reaction or malignant invasion. From one's experience, it is correct to assume that at the

tune of operation it is more likely that the larger percentage will be inflammatory. Obviously the morbidity from possible damage to the bladder ureter or urethra will be greater from fixation anteriorly than posteriorly. A thorough digital examination to estimate these points is very valuable.

Obstruction. The rectal ampulla is large and a growth must reach a very large size before obstruction ensues. If however the growth is at the rectosigmoid obstruction takes place sooner. The history and examination of the abdomen will give the desired information. Obstruction in itself is no contra indication to operation and if not relieved by medical means the surgeon may resort to a preliminary colostomy.

Obesity. Obesity constitutes a formidable block for several reasons. We know that in the obese individual regardless of the location of the malignancy cancer seems to spread faster than in the "smoked herring" type of individual. Obese individuals also seem to tolerate infection poorly. From a technical standpoint, the operation is much more difficult and time-consuming so that if one has a combination of fixation in the obese individual, the risk is far greater than in a thin one, both from the immediate mortality and the ultimate results. Sometimes the mesentery is so thick in these individuals that one may have extensive glandular involvement in the mesosigmoid and along the aorta which it is impossible to palpate. This condition, of course renders the ordinary case inoperable.

Size of the growth. One need not be discouraged by a large growth even though there may be some fixation. Experience shows that in many such growths there may not even be any glandular involvement. Frequently the prognosis is much better than with small growths of a more malignant nature which have already formed metastases. I recall several large bulky tumors of the rectosigmoid which had intussuscepted into the rectum, making the mass seem to appear much larger than it really was. Other factors led to exploration and finally to satisfactory end results.

Loss of weight and anemia are not necessarily contra indications to exploration. Un-

less one actually demonstrates metastases to the liver or lungs, the patient should be explored. We must remember that many of these patients complain of diarrhea. They think that its correction lies in dietary measures and this frequently accounts for loss of weight and secondary anemia. The anemia can be corrected easily by blood transfusion and then an exploratory operation can be done safely.

Associated chronic diseases such as diabetes, tuberculosis, and cardiorenal disease may occur in patients with carcinoma of the rectum, but they do not necessarily spell inoperability. It is important to emphasize at this point that operation for cancer of the rectum is not an emergency procedure. Plenty of time can be taken to rehabilitate the patient. Too frequently upon the finding of a carcinoma, both physician and patient become hysterical and demand prompt action. This hurry has cost many lives. These patients should be put in the hands of specialists in their various lines, and the eager surgeon should be handcuffed until the optimum time for surgery.

These foregoing factors relative to operability may be estimated before operation. However there are some facts that cannot be estimated before exploration. These are metastases to the liver or glands or fixation inside which could not be ascertained from rectal examination. Metastases to the liver make it incurable while the local lesion may be entirely operable. Personal equation enters into the handling of such a case. In addition to striving for cure the surgeon has another great obligation in case cure is not possible the relief of pain. For that reason I have many times completed the operation when there was liver involvement and have no reason to regret it. The pain and discomfort in the terminal stage is terrific and one must not protect his statistics to the point of allowing the patients to suffer. In a case where there is not much liver involvement, with the patient in a fair state of preservation, and with an operable lesion in which one does not take more than the average risk, I think it is our duty to remove it for the patient's comfort. I think that in this type of case palliative colostomy

is resorted to too frequently. We must distinguish the pain of obstruction from the pain of metastases. If the patient has no obstruction, colostomy does not give him any relief. In fact, it adds to his misery on account of the nuisance of the colostomy. Colostomy does not relieve the pain of metastases, and with the lesion *in situ* the patient still has what is so distressing, namely, frequency and urgency due to the mucus, pus, and blood from the ulcerating neoplasm. If the lesion is resectable, it should be done in preference to colostomy. Involvement of the mesenteric lymph glands constitutes one of the criteria of operability, but in my mind it is of minor importance because very frequently one cannot feel any glands in the fat, thick mesentery when there may be extensive glandular involvement. On the other hand, when one can feel them, it is frequently impossible to tell whether these glands are inflammatory or malignant, so that unless glandular involvement has increased to the point where there is fixation to the sacrum or lateral pelvic wall, the surgeon should proceed with the operation. Here again, the curability rate may be affected in one sense, but many whose enlarged glands turn out to be inflammatory will also be saved who otherwise would not.

Fixation to the seminal vesicles, bladder, and pelvic wall that cannot be determined until operation may contra-indicate operation in most cases. In women, however, fixation to the uterus does not make it inoperable. In 3 of our patients the uterus has been successfully removed with the rectum in one mass.

In recent years another criterion of operability has been added, namely, gradation of tumors. It increases our knowledge regarding cancer, and may prove valuable from a prognostic standpoint, but I am opposed to using gradation of tumors as a guide to therapeutic effort. If a case is clinically operable, I would not refuse operation because the pathologist said it was grade 4. The pathologist has been known to make mistakes.

Operability, then, is determined after an appraisal of all of the above mentioned factors. One must consider the patient as well as his disease. My philosophy regarding cancer of the rectum is to increase the scope of operability

constantly. The mortality may be increased a little but we will keep the patients comfortable for a longer period of time, and relatively more people will be alive at the end of 5 years than with a lower percentage of operability.

The type of operation must be left to the judgment and experience of the surgeon and to his facilities. Based upon my experience with cancer of the rectum, it is my belief that the abdominoperineal resection for carcinoma of the rectum offers the greatest hope of cure or immunity for a longer period of time than any other procedure. I am speaking of the great average number of cases who come to the surgeon. There are, of course, minor procedures which give occasional cures, namely, electrocoagulation or radium treatment of those patients who come to us in whom the carcinoma is limited to the mucosa. I have seen a number of this variety but in contrast with the total this group is so in the minority that it is almost useless to talk about them. It would be a happy period for the surgeon should the time arrive when we could see all of these cases early when a minor procedure, namely coagulation or radium, would give as high a percentage of cures as the most radical operation practiced today. Unfortunately, I must admit that the cases today in my experience are just as far advanced as those observed 20 years ago in spite of propaganda or education along these lines. This is due to a variety of circumstances that cannot be touched upon in this paper, but they are chiefly delay on the part of the patient in consulting the physician, when he knows that something is wrong, and neglect on the part of the physician to make an investigation when the patient does consult him.

Obviously, the greatest factor in increasing the curability rate is early diagnosis. It is unnecessary for me to state that half of these patients have been treated for hemorrhoids for months before they come to operation. It is not the wish of the profession to raise a race which may be addicted to cancerphobia. Such individuals often suffer just as much as the cancer patient himself. A thorough digital and proctoscopic examination in all cases of rectal bleeding from whatever cause will enable us to detect a large number of those neg-

lected cases without frightening propaganda to the public. Better diagnosis on our part will instill confidence in the patient, and discovery of an early lesion so impresses the patient that the physician frequently will note in the ensuing few weeks that he examines quite a few people who turn out to be relatives or friends of the patient. This is publicity along the proper lines and should be cultivated. In our present day knowledge wide surgical removal offers the best hope of cure. The surgeon must constantly widen the scope of operability and the operation itself taking into account of course certain limitations due to the general condition of the patient who has to be considered as well as the disease.

A few figures are presented as to operability and curability when the one stage combined abdominoperineal operation was performed

Operability One hundred patients had been examined 10 of whom refused any treatment whatsoever. Twenty patients of the 90 remaining were considered inoperable, 9 of whom received no treatment and 11 were given palliative measures. The number explored was 70 or 77 per cent. Thirteen of these were considered inoperable 10 had liver involvement and in 3 fixation had occurred. The 57 remaining, or 80 per cent, were operated upon. Fifty four had a combined one stage operation while 3 were subjected to different operations. There were 4 operative deaths in all or a 7.2 per cent mortality.

Curability Statistics showed that there was a 12 per cent hospital mortality among 100 patients. Metastases had occurred in 56 patients of this group 46 or 52.5 per cent, are still living and 54 have since died.

SURGICAL TREATMENT OF DUPLICATIONS OF THE ALIMENTARY TRACT

Enterogenous Cysts, Enteric Cysts, or Ileum Duplex

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DURING recent years we have treated 18 patients with cystic lesions which were situated along various parts of the alimentary canal, and here group them together as an entity, because there are certain features which are common to all of them. Inasmuch as these cysts have appeared in diverse locations and have had many shapes and sizes, a confusion of terms has arisen in the literature to describe the specimens. Such structures arise from tongue to anus (Fig. 1), appear to have a common derivation, and present similar problems. Hence, they should be grouped under one generic term. We have chosen to list them as "duplications of the alimentary tract."

The names most frequently applied to these lesions are "enteric cyst," or "enterogenous cyst." However, such terms are not inclusive enough, because some of the lesions are tubular and course through the mesentery parallel to the bowel or communicating with it. Likewise, they have been called "giant diverticula" but this, again, is unsuitable, because some of them do not possess the communication with the alimentary tube which this term suggests. "Ileum duplex" has previously been used to describe several of these specimens, but again, this does not adequately include the condition as seen in the jejunum, duodenum, stomach, or elsewhere in the gastro-intestinal tract. "Inclusion cysts" conveys the idea that some of these structures are an integral part of the intestinal wall, yet this certainly is not true in all of the cases here presented. It is, therefore, proposed that the general term, "duplication

of the alimentary tract," should be substituted for all of these names, since it is all inclusive and serves to bring these various lesions together as a single entity.

PATHOLOGY

Duplications of the alimentary tract are hollow structures which possess a muscular coat, usually of two layers, and are lined with epithelium similar to that found in some portion of the gastro-intestinal tract or colon. These lesions are always contiguous to some portion of the alimentary tube, and in all but one case they were strongly adherent to it. The type of epithelium lining the duplication does not necessarily correspond to that part of the alimentary tract to which the structure is attached. Thus, a cyst of the tongue was lined by colonic mucosa, and a cyst of the rectum was partially lined with gastric epithelium. The cystic structure may or may not communicate with the adjacent intestinal lumen. In 2 cases there was such a communication, but in the 16 remaining cases there was no opening.

An important finding is the histological fact that the muscular coats of the duplication are intimately adherent to and at times are microscopically an integral part of the muscularis of the alimentary tract (Fig. 6).

The contents of a duplication vary with the type of epithelium lining the structure, with the presence or absence of a communication with the adjacent intestine, and with the presence or absence of necrosis of the duplication wall. Thus, if there is an opening into the bowel, the duplication contents will be similar to those of the adjacent intestinal tract. In general, however, there is no communication with the intestinal lumen and the cystic struc-

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TABLE L—CASES OF DUPLICATIONS OF THE ALIMENTARY TRACT

Case no.	Age	Position of cyst	Size	Type of membrane	Treatment	Result
		Base of tongue	cm. in diameter	Colonic	Excision	Recovered
1000		Right pleural cavity	10 g cm. in diameter	Oesicous	Attempted excision	Recovered
101		Mediastinum	10 by 6 by 1 cm.	Oesicous	Excision	Recovered
1001		Right pleural cavity	6 by 1 by 1 cm.	Oesicous	Excision	Dead
1010		Along stomach	Large as stomach itself	Cystic	Marsupialization	Recovered
6	1012	Duodenum	4 by 6 by 3 cm.	Duodenal	Resection, posterior gastro-entrostomy	Recovered
	1004	Jejunum	11 by 6 by 6 cm.	Oesicous	Mikulicz resection	Dead
6	1010	Jejunum	cm. in diameter	Jejunal	Resection and anastomosis	Recovered
	1004	Ileum	1 by 1 by 1 cm.	Oesicous	None	Dead
10	10 1004	Terminal ileum	3 by 1 by 3 cm.	Colonic epithelium	Excision	Recovered
	1005	Terminal ileum	cm. in diameter	Ileal	Resection and anastomosis	Recovered
	1010	Terminal ileum	cm. in diameter	?	Not yet treated*	
	1001	Terminal ileum	cm. in diameter	Ileal	Resection and anastomosis	Recovered
14	6 yrs.	Ileum	cm. in diameter	Ileal	Resection and anastomosis	Recovered
	1010	Ileum	10 cm. long, cm. in diameter	Oesicous	Resection and anastomosis	Dead
15	1001	Cecum	cm. in diameter	Colonic	Resection and anastomosis	Dead
17	1010	Sigmoid	12 by 10 by 6 cm.	Ileal and colonic	Not treated	Dead
18	6 mos.	Rectum	1 by 1 by 1 cm.	Mixed	Excision, rectum repaired	Recovered

*This cyst was discovered during operation for acute appendicitis and has not yet been removed.

ture contains a clear colorless fluid of mucoid consistency. In 2 specimens the cyst had reached such size that there was pressure necrosis and sloughing of the lining membrane. Therefore the entrapped fluid was hemorrhagic and murky-colored.

The size of the specimens is variable. It depends upon the ability of the lesion to expand into adjacent cavities or tissues before giving symptoms, and upon the presence or absence of a communication with the intestinal tube. In one case a cyst at the base of the tongue was about a centimeter in diameter was lined by colonic mucous membrane, and was filled with a clear syrupy fluid. In 3 cases the structures were adherent to the esophagus and had ballooned out into the mediastinum and right pleural cavity. Hence they had grown to orange or grapefruit size before attracting attention. One specimen which arose from the greater curvature of the stomach in a 6 year old girl was almost as large as the normal stomach itself. The cystic lesions appearing along the duodenum jejunum, and

ileum, usually do not become larger than a golf ball before producing symptoms. In Case 15 the structure was sausage-shaped, was 38 centimeters long and 2 centimeters in diameter and ran along the mesenteric border of the terminal ileum. One duplication of the sigmoid was about the size of a large orange. Finally in a 6 months old patient, there was a cyst arising from the posterior rectum wall, which was somewhat larger than a plum.

The levels at which duplications have occurred in the present series were as follows: base of tongue 1, esophagus, 3, stomach, 1, duodenum, 1, jejunum, 2, ileum, 7, cecum, 1, sigmoid, 1, rectum 1.

It is important for the surgeon to recognize the pathological difference between duplications and mesenteric cysts. The latter are lymphatic in origin, have a thinner wall, and can be readily separated from adjacent viscera. This is in contrast to the duplication, which has a thicker muscular wall and which can be disconnected from the intestine only with difficulty.

EMBRYOLOGY

There are many theories which attempt to explain the origin of these duplications. Those arising in the mid or terminal ileum were previously thought to be due to aberrations in the development of a Meckel's diverticulum. However, this theory is no longer tenable. Twinning of an isolated portion of the embryo has been believed by some to be the causative factor. Sequestration, or a pinching off of a group of cells from the primordial intestinal tube, might well account for the development of nearby, closely placed cysts, which finally attain all of the histological elements of the wall of an alimentary tract. The most probable explanation is that advanced by Lewis and Thyng, who frequently found diverticula at various levels in the fetal alimentary tracts of pigs, rabbits, cats, sheep, and man. Such outpocketings were most common in the ileum, a fact which suggests a relationship to the high incidence of duplications in the ileum. These knob-like outpocketings of the intestinal wall, which are not related to Meckel's diverticula, normally regress, but the pinching off of one of these structures might well separate it from the normal intestinal wall and give rise to an adjacent duplication.

CLINICAL FINDINGS

A duplication of the alimentary tract is usually observed in children. It may be seen in later life, but the nature of the process is one which attracts attention in early years. Our youngest patient was 2 weeks of age, the oldest was 9 years.

The symptoms produced by these lesions may be grouped under 3 headings: (1) obstruction of the alimentary tract by regional external pressure, (2) pain produced by distention of the cystic structure, and (3) hemorrhage because of interference with the intestinal blood supply, leading to sloughing of the intestinal mucosa. In the lesion appearing at the base of the tongue, difficulty in swallowing was the outstanding symptom. With the cysts of the mediastinum and the right pleural cavity, there was esophageal compression and difficulty in swallowing, and there was interference with the proper expansion of the lung, which led to dyspnea. In the duplication of

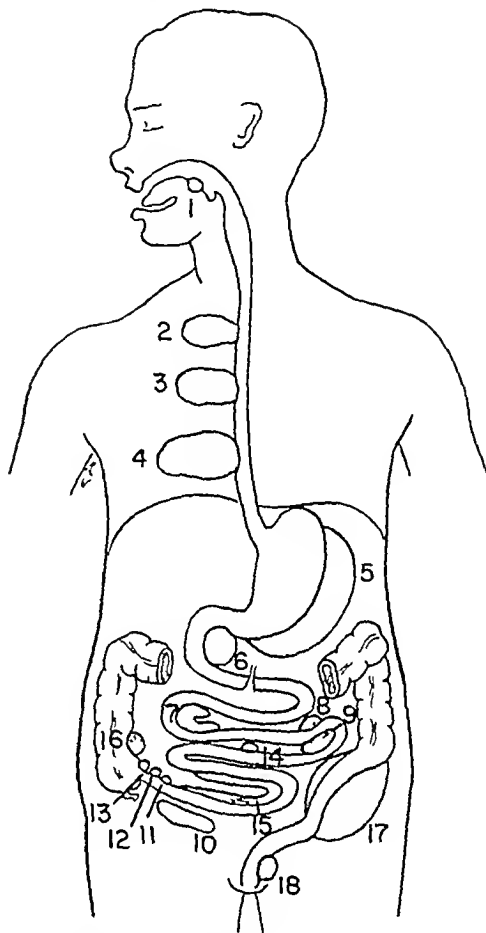


Fig. 1. Chart showing distribution of lesions in 18 cases of duplication of the alimentary tract. The number beside each lesion indicates the patient as listed in the table of cases.

the stomach, in spite of the large size of the lesion, the adjacent gastric lumen was not compressed sufficiently to cause obstruction, and the patient's primary complaint was related to epigastric fullness and pain produced by tenseness in the mass. Most of the cysts of the duodenum, jejunum, and the ileum brought early signs of partial intestinal obstruction characterized by colic-like pain, vomiting, increased peristalsis, and, finally, signs related to dehydration. In the long, tube-like duplication of the terminal ileum (Case 15), the primary complaints were related to severe painless hemorrhage from the lower intestinal tract, caused by ulceration



Fig. 2. Case 4. Roentgenogram of duplication of the esophagus which ballooned out into the right pleural cavity. The cystic lesion is outlined by arrow. Mediastinum and heart displaced to the patient's left side.

and sloughing of the ileal mucosa. Two small cysts of the cecum have been encountered, one of which produced partial obstruction and the other by bulging into the cecal lumen, served as the leading point of an intussusception. Finally the cyst of the rectal wall (Case 18) produced early encroachment on the adjacent rectal lumen and quickly led to constipation and abdominal distention.

Physical examination often gives important evidence concerning the position of the lesion and indeed the physical findings may strongly suggest the proper diagnosis. In a cyst at the base of the tongue the lesion can easily be palpated as a swelling below the foramen cecum. A thoracic cyst can be quickly suspected because of physical signs of dysphagia, dyspnea, and pulmonary compression. The duplication of the stomach was of such a size that it could be easily palpated running along in the direction of the greater curvature of the stomach. This mass lacked peristaltic waves and persisted after the evacuation of the stomach with a tube and the cleansing of the transverse colon with an enema. The cysts of the duodenum, jejunum, and ileum could be palpated in practically every case. They were elastic, well rounded, usually non-tender

and except for the duodenal lesion, were quite freely movable within the abdominal cavity. In each of these cases, physical examination revealed some sign of partial intestinal obstruction. Such signs were listed as visible peristalsis, localized or general abdominal distention and increased audible peristaltic activity. The tube-like structure along the terminal ileum in Case 15 could not be felt during examination of the abdomen and there were no physical signs of intestinal obstruction. The only finding in this child was the presence of blood on the glove when rectal examination had been performed. The cyst of the sigmoid was freely movable, elastic, non-tender and without signs of colonic obstruction. The cyst of the posterior rectal wall could be palpated easily with a rectal examining finger and though the lining of the rectum was smooth, it was displaced forward so that the examining finger could not be pushed up beyond the compressed point.

ROENTGENOLOGICAL FINDINGS

Duplications in the thorax give roentgenographic findings characteristic of mediastinal neoplasms or cysts. In 1 case there was a large well defined lesion displacing the upper lobe of the right lung. In the 2 other patients there was a large well circumscribed opaque mass without calcification which apparently arose from mediastinal structures and then ballooned out into the right pleural cavity to replace about two-thirds of the lung area in the anteroposterior chest films. The density of such a lesion is rather uniform due to its fluid content. The uniform shadow and the absence of calcification tend to distinguish it from a dermoid or teratoma. With some of the large lesions there may be a shift of the mediastinum and heart to the other side of the thorax (Fig. 2) but it was surprising to find relatively little displacement in some of these cases. Lipiodol visualization of the bronchial tree shows marked compression of the lung on the involved side.

In the patient with a duplication of the stomach roentgenographic studies were of considerable aid in roughly outlining the size of the lesion and in determining its position with relation to surrounding viscera. Thus, a

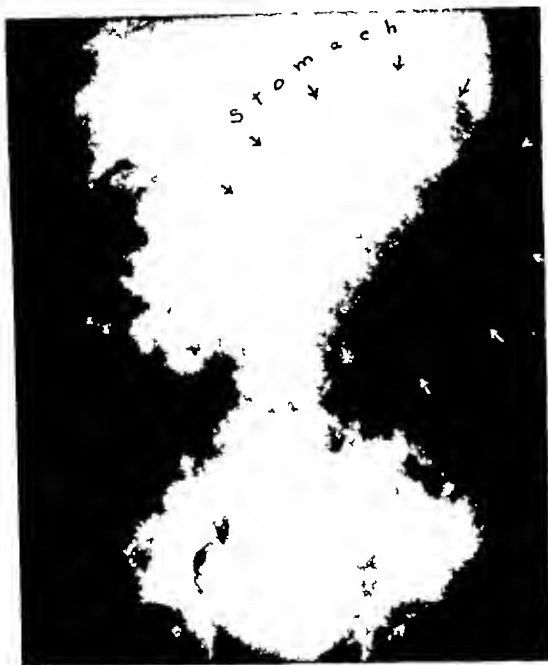


Fig 3 Case 5 Roentgenogram of duplication of stomach showing a large mass outlined by arrows beneath the stomach. The stomach is filled with barium and is indented along its greater curvature by the mass.

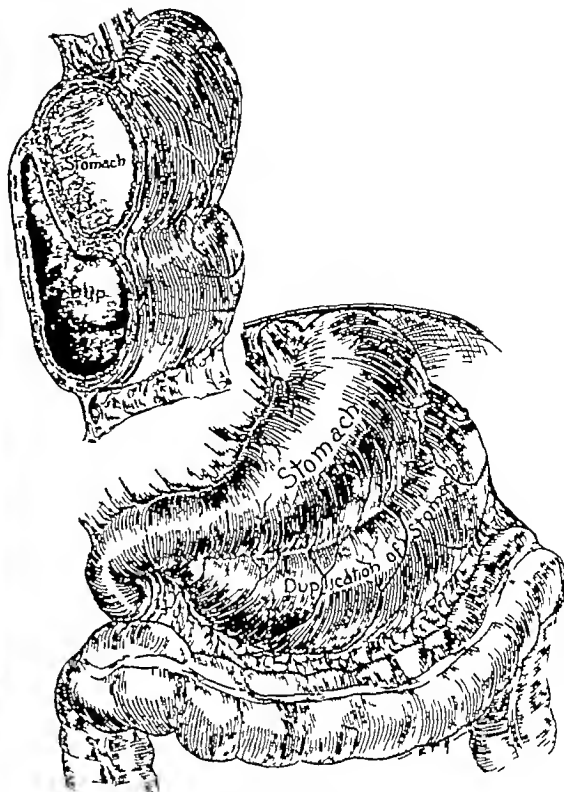


Fig 4 Case 5 Drawing of large duplication of stomach as found at operation with a cystic structure attached to greater curvature of stomach from the pylorus almost to the cardia. The blood vessels of right and left gastro-epiploic systems course over the duplication on their way to the gastric wall. Inset at left shows a cross section of the stomach and the duplication at the level of the gastric incision.

gastro-intestinal barium series showed a large extrinsic mass along the greater curvature of the stomach, which smoothly bulged into the gastric lumen (Fig 3). Following this examination, a barium enema showed the mass to displace the transverse colon downward without appreciable compression of this organ.

With the duodenal cyst (Fig 5) there was sufficient compression of the first and second portions of the duodenum to give evidence of partial obstruction at this level. The cystic lesions of the jejunum and ileum in some cases showed partial obstruction by x-ray visualization.

Usually as much could be learned from films of the abdomen in the postero-anterior and lateral direction without contrast media, as could be determined with the use of a barium gastro-intestinal series. Thus, distention of intestinal loops (Fig 7), particularly if they are localized to one portion of the abdomen, are indicative of obstruction and may give some impression concerning the level at which the lesion exists.

The large duplication of the sigmoid (Fig 12) showed a rounded area of rather uniform density with peripheral displacement of gas-containing viscera. A barium enema in such a case should outline the sigmoid as a flattened viscus, as it courses around the mass. In the cyst of the posterior rectal wall, roentgenographic examination was a great aid for 2 reasons. First, it gave some idea of the size and superior extent of the lesion in the lateral field (Fig 13), second, the absence of bony defect in the lumbar and sacral vertebræ gave some assurance that the pelvic mass was not an anterior meningocele.

TREATMENT

Obviously, the treatment of this condition is one requiring surgery. Two important facts

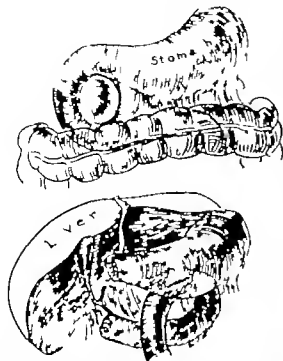


Fig. 5. Case 6. Duplication of first and second portions of duodenum as found at operation. Lesions treated by excision of cyst and partial resection of duodenum supplemented by posterior gastrojejunostomy. Patient recovered.



Fig. 6. Case 6. Photomicrograph of the mucosa all between the duodenum and the duodenal duplication. Duodenal mucosa is seen at left. The mucosa of duplication is shown at right. Between them are intermingled smooth muscle coats without plane of cleavage. This illustrates the difficulty which could be encountered when attempting to dissect these cysts away from the adjacent intestine.

must again be stressed regarding the pathology of these lesions in relationship to operative procedures. First, the cystic structure and the intestine have a common wall at one point, and the two cannot be dissected apart with safety; second, the blood vessels of the contiguous alimentary tube may course over the surface of the cyst, hence attempts at local removal of the cyst may induce ischemia and necrosis of the intestine. This latter consideration is particularly important in the treatment of a lesion of the small intestine and of the sigmoid, in which the vessels from mesenteric or sigmoidal leaves spread out over the surface of the cyst. In the lesion at the base of the tongue we had no difficulty in excising the mass completely working through the oral cavity.

The thoracic lesions have given us the greatest difficulty from the point of view of technical procedures, particularly when they have been treated in patients who are under 1

year of age. We have attempted in every case to open the thorax through a posterior or posterolateral incision, to enter the pleural cavity and then free the cystic structure from the adjacent lung, a dissection which can easily be performed. However on attempting to dissect away the cyst wall from the esophagus, the dangers of entering the esophageal lumen are high. In one of our cases the esophageal lumen was entered, and the surgical field was thereby transformed from an aseptic into a soiled one. On first consideration it would seem relatively easy to turn in the edges of the damaged esophagus, but it has been our experience that the closure thus affected heals poorly and there is great danger of establishing an esophagopleural fistula. This possibility of injury to the esophagus must be stressed because if the surgeon overlooks a small opening thus accidentally made the patient will subsequently develop a fatal mediastinitis or empyema whereas the recognition of the esophageal defect during operation allows the surgeon to make some provision for closing the defect or for treating regional infection which surely will subsequently develop. The poor results which have been obtained in these thoracic lesions, due primarily to the associated esophageal injury at time of operation, raises the possibility



Fig 7 Case 7 Lateral roentgenogram of abdomen showing dilated intestinal loops, accumulation of fluid between the loops, and marked abdominal distention. These findings are indicative of obstruction which at operation was found to be caused by a large duplication of the lower portion of the jejunum.



Fig 8 Case 7 Surgical specimen of duplication of the jejunum. The intestinal tract appears at the periphery of the specimen. The sausage shaped duplication is very adherent to the intestine on its mesenteric side and shows the impossibility of dissecting out the cyst without destroying the blood supply of the jejunum.

Therefore, by simply marsupializing this duplication onto the anterior abdominal skin, the release of all entrapped fluid allowed the walls to fall together and to coalesce. If one should not be so fortunate in having the mucous membrane thus spontaneously destroy itself, two methods of treatment are open, either by marsupialization and subsequent injection of sclerosing fluids, or by establishment of a large communication between the cyst and the stomach to permit drainage of the cyst contents into the gastric lumen.

In the patient with a cyst of the duodenal wall (Fig 5), the first portion of the duodenum and the mass were excised *in toto*, the ends of the duodenum were inverted, and a posterior gastrojejunostomy was performed with satisfactory results.

In those duplications of a cystic nature occurring between the duodenum and cecum, we have practiced complete extirpation of the mass, along with resection of the adjacent portion of the intestine. We have adopted this policy because experience has shown that the mass cannot be enucleated without the danger of perforating the intestine or leaving it in an ischemic state. In all cases, except one, we employed a side-to-side anastomosis to re-establish the continuity of the intestinal tract, because end-to-end anastomosis of the

that these patients might be treated better by marsupialization of the cyst through the posterior thoracic wall, combined with subsequent destruction of the cyst lining by the use of necrobiotic agents which could be easily introduced through the fistulous opening.

The duplication of the stomach, as exemplified in Case 5, might be treated in several ways. First, a total or nearly total gastrectomy with establishment of an esophagojejunostomy would permit the removal of the cystic structure along with the stomach. However, this appears to be a rather extensive undertaking, particularly in a young individual. This risk does not seem to be justified when simpler, more satisfactory forms of treatment are available. We were fortunate enough in our case to find a cyst so distended by accumulated secretory fluid that there had been sloughing of its entire mucosal lining



Fig. 9. Case 8. Photograph taken during operation showing golf ball sized duplication of the lower jejunum. The adjacent intestine is compressed over one surface of the cystic structure. Resection of cyst and adjacent intestine followed by lateral anastomosis—successful result.

small intestine in infants and children is technically difficult and may lead to disaster.

While it is our belief that the most satisfactory outcome will be insured by surgical excision of the mass and local resection of the adjacent intestine, mention must be made of the publication of Gardner and Hart, who treated a cystic lesion of the duodenum by a transduodenal approach and opened a large window from the duodenum into the cyst. This allowed the cyst to empty its mucoid contents continuously into the duodenum. The success of this procedure in Hart's case suggests that it might be worth trying in cases where a short operative procedure is necessary because of the poor general condition of the patient. It must be pointed out that stasis in such an outpocket from the intestine might lead to troublesome symptoms. Hence the opening into the cyst must be adequate to insure proper drainage.

Cysts of terminal ileum or cecum may so impinge on the ileocecal valve that partial obstruction is produced. The 2 specimens which we have encountered in this region demonstrated the impossibility of excising them from the cecal wall without injury to the remaining intestine or valve. Therefore we have again practiced local resection and establishment of an ileocolostomy.

The large cyst of the sigmoid which was discovered at autopsy demonstrated again that it would be futile to dissect the cyst from the sigmoidal loop and that the best method



Fig. 10. Case 8. Drawing of surgically removed specimen as shown in Figure 9. The duplication lies within the leaves of the mesentery, is intimately attached to the intestinal wall, and is partially obstructing the intestine by compression. The mesenteric arteries and veins course over the surface of the cyst as they are distributed to and from the intestine.

of treatment would be excision of the mass and the adjacent gut, re-establishment of the colonic continuity, possibly combined with a temporary cecostomy or transverse colostomy as a safety valve.

The duplication of the posterior rectal wall in Case 18 (Figs. 14 and 15) was first treated by the family doctor, who intermittently relieved the rectal obstruction by aspirating the cyst through a posterior sacral approach. Fortunately infection did not occur. Each time the cyst was aspirated it refilled in 5 or 6 days' time and again displaced the rectum forward in such a way as to obstruct its lumen. Operation on this 6 month old baby was performed under ether anesthesia, with the child in the face-down position and the abdomen supported on a sand bag so as to push the buttocks high up in the operative field. A curved incision, posterior to the anus, permitted displacement of the anus and anal sphincters forward. Then by carrying the dis-

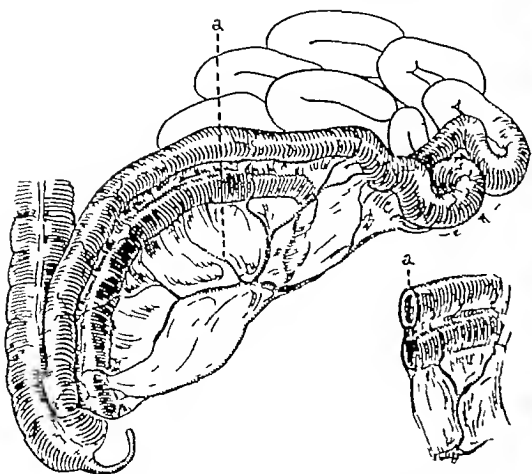


Fig 11 Case 15 Drawing of long tubular duplication of the lower ileum Duplication 38 centimeters long Insert *a*, shows the duplication within the leaves of the mesentery adjacent to the normal ileum

section upward in the midline between the levator ani muscles, the hollow of the sacrum was reached, and the cyst behind the rectum was exposed. Little difficulty was encountered in dissecting the cyst along its posterior, superior, and lateral surfaces, where good lines of cleavage were obtained. However, the cyst was found to be extremely adherent to the rectal wall, and in the course of the dissection a large opening was made in the posterior portion of the rectum. The rectum was now repaired by turning it inward with 3 layers of interrupted, fine, chromic catgut sutures. A small rubber drain was led down into the hollow of the sacrum, and brought out through the skin incision. The rectal wall healed *per primam*. There was no suppuration in the perirectal spaces, and the child quickly recovered.

SUMMARY

Attention is directed to duplications of the alimentary tract. These are congenital abnormalities, presumably produced by pinching off a small bud from the gut wall with development of this segregated tissue into a cystic structure adjacent to the normal intestine. Such cystic lesions may appear at any level from the tongue to the anus. Treatment consists of complete excision of the cyst if possible, with removal in addition of the at-



Fig 12 Case 17 Photograph of abdomen at autopsy showing a cystic duplication (12 by 10 by 8 centimeters) of the sigmoid in a 2 week old infant. Arrows indicate the flattened sigmoid, 1, as it courses over the surface of the duplication, 2.

tached portion of the alimentary tract, if this is feasible. If such excision cannot be performed, a window may be cut between the cyst and adjacent intestine to establish drainage, or the cyst may be marsupialized and its lining cauterized with sclerosing agents. When operation is based on these principles, the results of the surgical procedures have been good.

CASE REPORTS¹

CASE 5 E. L., a 7 year old girl, complained of recurring abdominal pain and vomiting for 9 months. Each attack usually lasted for 2 or 3 days and occurred at 2 or 3 week intervals. During attacks she vomited 5 or 6 times a day.

Physical examination showed the patient to be poorly nourished and somewhat pale. There was diffuse tenderness and rigidity in the abdomen which was more marked above the umbilicus. Just above the umbilicus a large ovoid mass could be felt running across the abdomen from one costal margin to the other. This was quite tender. It was smoothly rounded and definitely cystic.

Laboratory data revealed the urine to be negative. Routine blood studies were negative. There was no leucocytosis. Roentgenograms of the abdomen showed a large, soft, tissue mass filling the upper portion of the abdomen, extending more to the left.

¹Case 3 was reported previously by Mixer and Clifford and Cases 7 and 15 were published by Hudson. Cases 1, 2, 5, 6, 10, 11 and 13 were listed in an address by Ladd.



Fig. 3. Case 8. Lateral roentgenogram of patient with cystic duplication of the rectum. Barium in the rectum shows it to be displaced forward by a mass lying in the hollow of the sacrum.

Gastro-intestinal roentgenograms outlined the stomach and showed it to be encroached upon and compressed by the mass (Fig. 3). A barium enema showed some downward displacement of the transverse colon by extrinsic pressure of the mass.

Under ether anesthesia laparotomy was performed. A large, smooth, elongated cystic lesion was found adherent to and running along the greater curvature of the stomach. This cystic mass was intimately attached to the gastric wall, and though there was a slight groove between this and the stomach, there did not appear to be any plane of cleavage to permit a safe dissection of the mass away from the stomach. Furthermore, the blood vessels of the right and left gastro-epiploic systems coursed over the anterior surface of the mass and then ran up onto the gastric wall. It appeared too hazardous to attempt encision of the cyst, and hence its suppurization was decided upon. A considerable portion of the cyst was exteriorized by bringing this out at the central portion of the wound. After the abdomen was then closed, the exteriorized portion of the cyst was approximately 5 centimeters in length and 5 or 6 centimeters in diameter. This presenting portion was cut off and nearly liters of watery, chocolate-colored fluid were evacuated. The internal lining of the cyst was distinctly hemorrhagic and necrotic. To insure destruction of any viable cells which might yet line the cyst, the remaining cavity was tightly packed with gauze.

The pack was removed on the sixth day. Subsequent dressings were changed frequently. The amount of discharge quickly diminished. By the time of hospital discharge 6 weeks after operation, the wound had completely healed over. The patient has been followed for 3 years since operation and



Fig. 4. Case 8. Photograph of duplication of rectum which was surgically excised.

there have been no further recurrences of her symptoms. Presumably the great distention in the cyst brought about from secretion of fluid by the lining spontaneously destroyed the lining and by marsupialization the cyst cells were permitted to coalesce.

The excised portion of the cyst wall was examined histologically. This was fibrous, very edematous, and was infiltrated with many polymorphonuclear cells. On the inner surface there was variable amount of fibrinoid and hemorrhagic material. The lining membrane had been entirely destroyed. Beneath the serosal covering were well defined, smooth, muscular coats.

CASE 6. P. S. was a 5 week old baby who was admitted because of vomiting since birth. She had been born at full term by normal delivery and weighed 8 pounds 9 ounces. On the second day she vomited blood. This was diagnosed as hemorrhagic disease of the newborn for which she was treated by transfusions and blood given intramuscularly. During this period she had black, tarry stools. On the fifth day the symptoms of intestinal bleeding had disappeared. On the thirteenth day she was discharged from the maternity hospital, weighing 7 pounds 8 ounces. The child did not do well at home in spite of the fact that she seemed to nurse well at the breast. She regurgitated, good deal and lost weight. Ten days before admission to the Children's Hospital she began to vomit everything given by mouth and examination demonstrated an abdominal mass.

Physical examination on admission revealed that the baby was dehydrated and poorly nourished. Her weight was 6 pounds 8 ounces. Her throat was slightly red and there were coarse rales heard in both lungs. In the midline of the abdomen, just above the umbilicus, there was a freely movable, soft, cystic mass, measuring about 4 centimeters in diameter.

Several diagnoses, including mesenteric cyst, omental cyst, and enteric cysts, were considered before operation. By exploratory laparotomy, a large enteric cyst of the upper duodenum was found (Fig 5), which could not be dissected from the intestine. Therefore, the resection of the cyst, together with the first portion of the duodenum, was performed, followed by a posterior gastrojejunostomy. Following operation the baby's temperature fell to 95 degrees and then rose to above 103 degrees within the space of a few hours. Her condition was very precarious. A transfusion and parenteral fluids were given. A week after operation her temperature became stabilized and she took her feedings well. When she was discharged 7 weeks after admission she had gained a pound and a quarter since operation. The child has been well for 3 years since the operation.

The pathological specimen consisted of a portion of small intestine measuring 25 centimeters in length and 1.5 centimeters in diameter. Along the mesenteric border was attached a concave portion of a cyst wall measuring 4.5 by 3.5 centimeters in greatest diameter. The serosa of the bowel was continuous with that of the cyst. It was smooth over the bowel, however, over the cyst there were numerous small tabs of fibrous tissue.

The lining of the cyst was dark pink in color and finely injected throughout. The intestinal mucosa was pale, pinkish gray in color, and slightly edematous. No opening between the cyst and intestine could be found.

Microscopically, the cyst had a well defined outer and inner smooth muscle coat. Lining the cyst was an epithelium similar to that of normal duodenum, except for the fact that the glands were not as deep as those of the adjacent duodenum. There were, however, numerous Brunner's glands. One of the sections had been cut from the specimen in a manner to include the wall between the cyst and the duodenum and to show the surfaces which lined these 2 structures (Fig 6). It was quite evident that the muscular coat of the cyst intimately fused with that of the duodenum. The final diagnosis was cystic duplication of the duodenum.

CASE 7. L. A. was a 6 month old female infant who was admitted to the Children's Hospital for the treatment of progressive abdominal distention and bilious vomiting of 2 weeks' duration. During this time she had been given daily enemas for constipation. 1 or the 4 days before admission the child had been febrile.

Physical examination showed an infant who appeared chronically ill. The abdomen was markedly distended, rigid, and tympanitic except in the right lower quadrant. Here there was a palpable, firm, rounded mass about the size of a grapefruit. This mass could not be reached by rectal examination. The tumor was only slightly movable. Physical examination was otherwise negative.

Soon after admission the abdominal mass was difficult to palpate. Roentgenographic examination

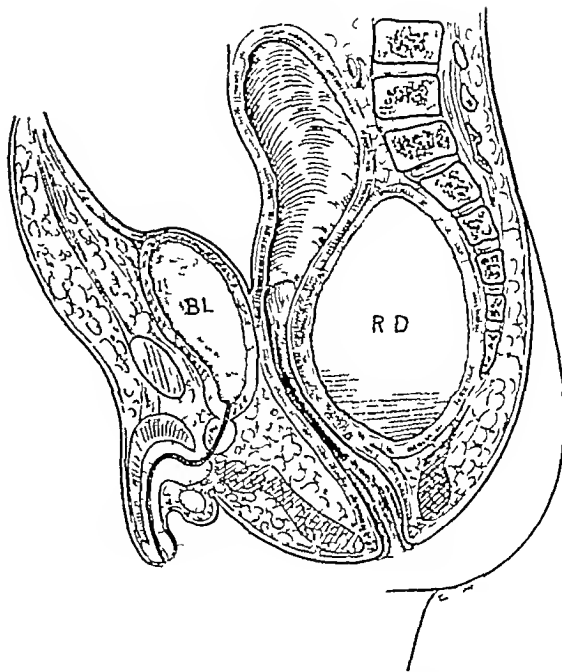


Fig 15 Case 18 Reconstruction drawing showing the duplication anterior to the sacrum and producing partial obstruction of the rectum. Surgically treated by excision of cyst and part of posterior rectal wall. Rectum accidentally opened in excision of cyst. Suture of rectal defect followed by recovery. BL—bladder, R D—rectal duplication.

(Fig 7) showed free fluid and gas in the peritoneal cavity, which was interpreted as being due to a ruptured viscus. Operation showed diffuse peritonitis and a large cyst attached to the jejunum. The cyst had not actually perforated, but at one point was very thinned out and necrotic. The cyst, with about 14 inches of jejunum, was resected and followed by a double barrelled enterostomy of the Mikulicz type. The child suffered considerably from postoperative shock, but on the fourth day seemed to be in good condition. At this time it was evident that the great loss of fluid through the jejunostomy was rapidly dehydrating the child in spite of parenteral administrations of fluid. On the fifth postoperative day a small clamp was placed between the 2 loops of the jejunum. On the seventh day the wound broke open and the abdominal contents eviscerated. The wound was resutured, but the child failed to survive.

The pathological specimen consisted of a segment of small intestine and associated mesentery, measuring 45 centimeters in length (Fig 8). Lying within the leaves of the mesentery was a thick-walled, cone shaped, cystic mass measuring 22 centimeters in length and tapering from a large dilated end, which measured 6 centimeters in diameter, to the smaller end, which measured 2.5 centimeters in diameter. At

the larger end there were constricted areas 5 centimeters in length with lumen 3 millimeters in diameter. At the distal end and between the constricted areas the lumen was dilated to a diameter of centimeter.

The surface of the cystic structure was extremely congested and in places there were small accumulations of yellowish-brown fibrinopurulent exudate. The wall varied from 7 to 8 millimeters in diameter. The lumen was generally smooth and glistening, although extremely hemorrhagic in some areas. The color of the lining varied from pale yellowish-gray to pinkish-gray. An area of ulceration, 2 centimeter in diameter, was present in the dilated portion. The serosa over this area was dull brownish-gray and congested. The wall at this point measured approximately millimeter in thickness, but there was no perforation.

Microscopically, the cyst was lined with a gastric type of mucosa. There were large open crypts, at the bases of which there were branching gastric glands containing parietal and chief cells. Areas of ulceration were present, and there was fibrinous exudate on the surface, but the underlying submucosa presented more marked inflammatory reaction than elsewhere. The muscularis was of two thick layers with bundles of diagonally-running, smooth-muscle fibers in addition. The serosa was elementous, congested, and infiltrated by variable number of lymphocytes, polymorphonuclears, and macrophages. A section, including both cyst and jejunum, showed the muscularis of each closely applied to the other with only a thin layer of connective tissue.

The diagnosis was cystic duplication of the jejunum with gastric type mucosa and acute and chronic inflammation.

CASE 8. D. B. was a week old male infant in whom an abdominal swelling had been noticed for days. At 6 days of age the patient developed diarrhea which was first thought to be infectious in nature. On the eleventh day of life there was an onset of vomiting which persisted until hospitalization. On the twelfth day physical examination disclosed a mass in the lower abdomen.

Physical examination revealed that the patient was well developed and nourished but somewhat dehydrated infant. The important finding as related to the presence of a smoothly rounded, slightly fluctuant, non-tender mass about 3 centimeters in diameter which could be moved freely in the lower abdomen. This mass could be barely felt at the tip of the finger by rectal examination. The stool did not contain gross or microscopic blood.

Laparotomy was performed under ether anesthesia. At the level of the lower jejunum a cyst about 4 centimeters in diameter was found within the leaves of the mesentery immediately adjacent to the intestine. The intestine coursed over one side of the mass and was greatly compressed thereby (Fig. 9). The intestine above the mass was slightly dilated and was distinctly larger than the intestine below the lesion. The arteries and veins of the mesentery

were clearly visualized as they coursed over the surface of the cyst from which they were distributed on to the intestinal wall (Fig. 9).

Realizing that this was a duplication made no attempt to peel the cyst from the mesentery or the intestinal wall. Resection of the mass and about 4 inches of adjacent intestine were performed. Both ends of the intestine were turned in and side-to-side anastomosis was established. The child did well after the operation and was discharged on the twenty-ninth postoperative day.

The pathological examination showed cyst weighing 45 grams. The intestine was so compressed by the adjacent cyst that its lumen was narrowed to 3 or 4 millimeters (Fig. 10). The peritoneal coats of the mesentery coursed up over the cyst and then continued on as the serosa of the intestine. The blood vessels of the mesentery could be seen coursing along the cyst wall from which they are distributed to the gut. When the cyst was opened, the wall was found to be to 3 millimeters in thickness and the lumen contained clear glistening, colorless material. The gray glistening mucosal lining of the cyst as thrown up into folds suggesting valvulae connatae. Microscopic examination of the cyst lining was essentially the same as the mucosal lining of the adjacent jejunum. There was moderate eosinophilic and neutrophilic leucocytic cell reaction in the cyst wall. There are few fibers suggesting rudimentary muscularis mucosae. Outside of this there was well developed muscular coat consisting of two distinct layers. These, however, were much thinner than the muscularis of the adjacent intestine. The findings were typical of duplication of the jejunum.

CASE 9. J. R. was a 6 month old female infant with recurring difficulty in moving her bowels since the age of 3 months. She had been treated by her family physician, who found pelvic mass which pushed the rectum forward so as to compress it and at times almost completely obstruct it. This mass was thought to be elastic and cystic. The family physician had aspirated the cyst on several occasions by passing needle into it through the skin of the coccygeal region. Each aspiration completely collapsed the mass and relieved the baby's symptoms of obstruction. However the cyst always refilled in 6 to 7 days time and would reach its previous size. Fortunately at no time was there ever any infection or suppuration of the cyst because of these needlings.

Physical examination revealed the patient to be well developed and nourished child with marked abdominal distention. Rectal examination disclosed mass pressing the rectum from behind forward as previously described. This mass was the size of plum and appeared to fill the hollow of the sacrum. Because of the possibility of an anterior meningocele, roentgenographic examination was performed, which showed no defect in the bone of the lumbar or sacral spine. These findings tended to exclude the possibility of meningocele. A barium enema examination showed marked anterior displacement of the rectum (Fig. 11).

Under ether anesthesia the child was placed face downward with the body raised by placing the abdomen over a sand bag. A curved incision about $2\frac{1}{2}$ inches in length was made posterior to the anus and was deepened to permit forward displacement of the anus and anal sphincter. Thus, by dissecting upward between the levator ani muscles, the hollow of the sacrum was reached and a smoothly rounded oblong cyst was encountered (Fig 15). This could be easily dissected away from the sacrum and its lateral attachments. On carrying the dissection forward, the mass was found to be very adherent to the rectal wall, and in spite of extreme care in cutting away the structure the rectum was opened for a distance of about 1 inch. After the cyst was thus removed, the rectal wall was repaired with 3 layers of interrupted fine chromic catgut sutures.

After operation the rectum was kept empty with occasional irrigations. The cutaneous wound was frequently dressed in order to keep it as clean as possible. No suppuration occurred in the perirectal fossa, and the skin healed *per primam*. The child recovered completely and was discharged on the tenth postoperative day. There was no rectal fistula. The child has been followed for $1\frac{1}{2}$ years since this operative procedure.

The pathological specimen was an ovoid cyst measuring 5 centimeters in length and 2.5 centimeters in diameter (Fig 14). When the specimen was opened it was found to be filled with clear, yellowish fluid. The wall of the cyst was approximately 2 millimeters in thickness. The internal surface was smooth, gray, and had a velvety appearance suggesting that the lining was composed of a mucous membrane. Histological examination showed the mucosal lining to consist of many types of epithelial

surfaces varying from the simple columnar, both with and without goblet cells, to stratified squamous and ciliated epithelial cells. A large part of the mucosa showed shallow crypt formations of the epithelial glands which contained chief and parietal gastric cells. The change from one type of mucosa to another was abrupt and without transition. The submucosa was composed of a loosely arranged areolar tissue surrounded by a moderate number of plasma cells, lymphocytes, and an occasional polymorphonuclear cell. The muscularis was composed of smooth muscle fibers and was arranged in a heavy inner circular and a somewhat lighter outer longitudinal layer.

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THE CONTROL OF HEMORRHAGIC TENDENCIES

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A DISCUSSION of hemorrhagic tendencies of surgical patients might be grouped as follows: (1) bleeding from lesions of the gastro-intestinal tract (2) tendency to bleed exhibited by patients who have lesions of the biliary tract and jaundice and (3) tendency to bleed exhibited by patients who have certain blood dyscrasias, such as purpura hemorrhagica hemophilia and pseudohemophilia.

GASTRO-INTESTINAL BLEEDING

Duodenal ulcer. In a study of 668 cases of gastro-intestinal bleeding by Rivers and Wilbur (32-33) it was found that in 60 per cent of the cases a blood vessel in a duodenal ulcer was responsible for the condition. Although in some cases bleeding may be caused by a duodenal ulcer on the anterior wall of the duodenum, the most frequent site in which bleeding occurs in the duodenum is the posterior wall of this structure. Ulceration usually extends into one of the branches of the gastroduodenal artery. It is the patient who has a bleeding ulcer of the posterior duodenal wall who may have a fatal hemorrhage and the condition is more likely to afflict those patients in or beyond the fifth decade of life. Although the incidence of fatal hemorrhage resulting from an ulcer of the posterior duodenal wall has been variously estimated to be from 3 to 8 per cent I believe that if a determination was made of the mortality rate arising from hemorrhage in that group of patients who are brought into the hospital during the phase of active, serious bleeding the mortality rate would be much higher. This is a point I wish to emphasize for I believe that too often patients having a chronic bleeding duodenal ulcer may be denied the opportunity of undergoing surgical procedures which can be performed in the non hemorrhagic stage at a low risk. In a paper covering this subject, Finsterlin emphasized that in his series of cases the

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Incidence of fatal hemorrhage among patients who bled seriously from duodenal ulcer and who were not operated upon varied from 50 to 30 per cent.

At The Mayo Clinic, in the treatment of the patient who has a bleeding duodenal ulcer and who is operated upon in the remissive stage of the hemorrhage we like to remove the duodenal ulcer and provide a sufficient portion of the duodenum remains to close accurately to perform partial gastrectomy if the condition of the patient permits. On many occasions, however in which the ulcer is too large to warrant removal gastro-enterostomy has healed the duodenal ulcer and hemorrhage has not recurred. While attending the meeting of the International Society of Surgery last year at Brussels, and in subsequent visits to several of the larger surgical clinics in Central Europe and Scandinavia, I gained the impression that there was an increasing tendency to regard the patient experiencing serious bleeding from duodenal ulcer as an emergency patient, comparable to the patient who has bleeding in any other part of the body. When operation was performed for such patients, control of the bleeding was the initial objective and the operation was performed in the easiest and safest way possible. Frequently all that was necessary was to open the duodenum and suture ligate the bleeding vessel.

Gastric ulcer. The bleeding gastric ulcer is always perforating in nature and extends into the gastrophrenic omentum. Such a lesion in my opinion always requires surgical treatment, and the best method of removal is partial gastrectomy.

Benign tumors of the stomach. Benign tumors of the stomach, such as adenomyomatous polyps fibromyomas neurofibromas, and leiomyomas occur with greater frequency than might be expected. Their incidence varies from 3 to 5 per cent of all gastric lesions. These tumors, even though they are small frequently may bleed so constantly that marked secondary anemia develops. Usually

gastric symptoms are absent unless the polyp has a pedicle which is long enough to obstruct the pylorus. The only symptoms of which many patients complain are those associated with anemia, such as weakness, dizziness, and the like. Not only do these benign lesions bleed, but adenomyomatous polyps not infrequently exhibit malignant degenerative changes in their periphery. Leiomyomas may degenerate and metastasize to the liver, as described by Sworn and Cooper. Such lesions, of course, require surgical treatment and should be removed. Usually all that will be necessary is excision of that portion of the stomach which contains the tumor. If degenerative or malignant cells are found on immediate frozen-section study—a procedure that should be an essential part of the examination—partial gastrectomy should be performed immediately. In an occasional case, there are certain types of medullary gastric carcinoma from which constant bleeding will produce anemia to the extent that when the patient is examined the anemia may be thought to be primary in type. Therefore, unless the examiner is aware of the possibility that a silent benign or malignant lesion of the stomach or colon may be responsible, and unless roentgenological and enteroscopic examination is made of the stomach and colon to eliminate the presence of such lesions, they may be overlooked and eventually may grow to such a large size, particularly if they are malignant, as to become almost inoperable before presenting associated gastro-intestinal symptoms. The following case is one in point.

CASE 1 A man, aged 57 years, had been treated elsewhere for 4 months for what had been called "anemia." Although there was some temporary response to hepatic therapy, with recurrence of the anemia and the appearance of symptoms of abdominal fullness after meals, a roentgenological examination of the stomach revealed an extensive malignant lesion of doubtful operability (Fig 1 a and b). At operation an extensive carcinoma of the stomach, grade 3 (Broders' index), was found and subtotal gastrectomy was performed. No glandular involvement was found. The patient recovered from the operation and was living 2 years later when he was last heard from.

BLEEDING LESIONS OF THE COLON

Next to the stomach and the esophagus (varices), the most frequent site of bleeding

gastro-intestinal lesions is the colon. The frequency with which a carcinoma of the cecum may produce anemia without the presence of other symptoms is well known to everyone, and yet not infrequently, because of the paucity of symptoms referable to the colon, the possibility that a patient who has anemia may also have a bleeding cecal carcinoma may escape attention. As in the stomach, so in the colon, single and multiple polyps which bleed may be present. In the colon, lesions have an even greater tendency to be malignant than they do in the stomach. Indeed, Dixon believes that in all such polyps malignant cells can be found. The corollary of this belief is that such polyps should be removed. Some of them, fortunately, situated in the rectum and in the sigmoid flexure of the colon, can be visualized through the proctoscope and can be destroyed by electrocoagulation.

MECKEL'S DIVERTICULUM

Although the incidence of Meckel's diverticulum is only about 2 per cent, the possibility that an ulcer in such a diverticulum may be the cause of silent gastro-intestinal bleeding, particularly among young adults, must always be borne in mind. Numerous instances of malignant lesions of Meckel's diverticulum have been reported (28). I have operated on 2 patients who had sarcoma in a Meckel's diverticulum, for both of these patients silent intestinal bleeding and anemia were the outstanding symptoms. In one of the patients, perforation of the lesion to the posterior parietal peritoneum was identified by roentgenological examination of the small intestine after the patient had ingested barium (Fig 2).

HEMORRHAGIC TENDENCY IN PRESENCE OF BILIARY TRACT AND LIVER LESIONS

Recognition of the factors contributing to the hemorrhagic tendency of patients who have obstructive jaundice and the development of newer methods of control should be emphasized.

The tendency of jaundiced patients to bleed has been well known for many years. Prior to 1919 bleeding was present in a high percentage of those jaundiced patients who failed to recover from their operation on the biliary tract.

In 1921 I suggested a method of pre-operative preparation of jaundiced patients which consisted of the intravenous injection of calcium chloride to combat the hemorrhagic tendency, and the intravenous injection of solutions of glucose to compensate for malfunction of the liver (39). In addition the patient was placed on a high carbohydrate diet and it was suggested that the patient's fluid intake be increased to 3,000 to 4,000 cubic centimeters daily. To deeply jaundiced patients pre-operative transfusions of blood were given. Abundant experimental and clinical data supporting the thesis of this method of improving the condition of the jaundiced patient are available in the research work of Mann and Magath on the effects of total hepatectomy, and the effectiveness of calcium chloride as an aid to hasten coagulation of the blood has been demonstrated by Wright, and Lee and Vincent.

As a result of the aforementioned measures and a better understanding of the problem of the jaundiced patients, as well as the institution of improved surgical methods, and the recognition of the proper time for the institution of surgical procedures among jaundiced patients, the mortality rate in operations upon jaundiced patients at The Mayo Clinic decreased progressively to the point where in 1936 only 2 cases of fatal hemorrhage in 309 jaundiced patients occurred. In 1937 181 jaundiced patients were operated upon with 7 deaths due to hemorrhage. In 1938 in 194 jaundiced patients operated upon there were 2 cases of fatal hemorrhage.

In 1935 Quick, Stanley Brown, and Bancroft showed that a definite relationship existed between a deficiency in prothrombin and hemorrhagic diathesis in jaundice, and they cited evidence to prove that in the presence of biliary obstruction the only substance lacking for the proper coagulation of the blood is prothrombin and that fibrinogen, calcium and thromboplastin are all present in normal quantities in the blood of jaundiced patients.

About this same time Hawkins and Brinkhous, studying the effect of complete biliary fistulas in dogs, found a deficiency of prothrombin in the blood. They were able to correct the deficiency of prothrombin occurring among such animals by feeding bile and emphasized

therefore the necessity of bile being present in and absorbed from the intestine.

Earlier studies by Dam and his co-workers (10-14) demonstrated that internal, subcutaneous, and intramuscular hemorrhages developed in chicks fed on a diet deficient in certain fat soluble compounds. This hemorrhagic tendency is, as Dam first indicated (11-12) promptly cured by administering a substance obtained from hog-liver fat and from alfalfa, which substance was described as the "coagulation vitamin" or vitamin K.

Thus, there are two factors, the presence of bile in the bowel and a hypothetical fat soluble vitamin, which are known to be of importance in maintaining normal concentration of prothrombin in the blood. Among patients who have obstructive jaundice bile acids are excluded from the intestine and, in addition, if the obstruction is of an extreme degree damage to the liver may occur which will be sufficient to produce a deficiency in prothrombin.

The early clinical application of this knowledge concerning vitamin K was begun independently in the United States by Warner Brinkhous and Smith at the University of Iowa, and by Butt, Snell and Osterberg (7) at The Mayo Clinic. In Europe it was begun by Dam and Glavind in Copenhagen.

During the past 2 years practically all patients encountered at The Mayo Clinic, who had obstructive jaundice and who were operated upon, received vitamin K and bile salts prior to surgical treatment.

For purposes of routine pre-operative treatment, jaundiced patients are divided into 3 groups (1) those who have a normal prothrombin clotting time (2) those who have a prolonged prothrombin clotting time but not active bleeding and (3) those who have a prolonged prothrombin clotting time and active bleeding.

Those jaundiced patients of the first group who have a normal prothrombin clotting time nevertheless, receive prophylactic treatment for from 2 to 5 days before surgical intervention is undertaken. From 2 to 6 gelatin capsules, each capsule containing approximately 200 milligrams of alfalfa concentrate together with from 1 to 4 gram of animal bile salts,

seem to constitute an adequate daily dose. Almost any type of animal bile salts can be used, but we have preferred water-soluble bile salts, particularly in those instances wherein concentrates of vitamin K must be administered by means of a duodenal tube or T tube. Human bile obtained from a biliary fistula or a T tube as previously described by Butt, Snell, and Osterberg (7) or lyophilized bile as described by Johnston may also be employed.

The condition of patients having jaundice who have an elevated prothrombin clotting time constitutes a potential or real emergency and has been treated as such. Most patients having a prothrombin clotting time of from 30 to 45 seconds will respond well to the plan of prophylactic treatment previously mentioned, but if the prothrombin clotting time is longer than 45 or 50 seconds, it has been thought advisable to administer concentrates of the vitamin together with bile salts, either by duodenal tube or after operation through a T tube. In such instances, from 2 to 4 grams of a water-soluble bile salt is dissolved in from 250 to 500 cubic centimeters of warm physiological solution of sodium chloride or tap water, to this is added from 1 to 2 grams of the concentrate of alfalfa containing vitamin K. The mixture is shaken thoroughly and is administered slowly in from 30 to 60 minutes by the drip method, care is taken to keep the solution warm and well mixed. One such dose, as a rule, will bring the prothrombin clotting time to a normal value. In the exceptional instance it has been necessary to repeat this procedure one or more times. When large or repeated doses are used, the prothrombin clotting time usually decreases within 6 to 12 hours.

The problem of treatment of patients who are actively bleeding is difficult. Clotted blood must be removed by lavage before adequate absorption of the vitamin can occur, and not infrequently gastric lavage and irrigation of drainage tubes leading from the biliary tract are required. A transfusion of blood often is necessary to aid in combating the shock produced by hemorrhage and to provide a temporary supply of prothrombin, a transfusion will, as a rule, control bleeding only so long as the added supply of prothrombin lasts, a matter of from 6 to 12 hours. Rhoads and Panzer

suggested that "bank blood" is low in prothrombin and is, therefore, of little value in controlling hemorrhage in these cases. Treatment with the vitamin concentrate and bile salts is carried out in the meantime as described in the preceding paragraph and repeated as necessary.

The administration of capsules containing vitamin K and bile salts to some patients following operation was difficult, but in these cases as well as those in which it was essential that large quantities of the vitamin K be absorbed as rapidly as possible, the vitamin was administered directly into the duodenum through a tube. Hence, to obviate such a procedure, various methods were tried for the parenteral administration of vitamin K. At first vitamin K was mixed with an oil substance, such as peanut oil, and was injected intramuscularly. But in these instances it was apparent that it required several days for any noticeable decrease in the concentration of prothrombin to appear, and in addition, the region of painful induration at the site of the injection was objectionable to the patient.

Almquist and Klose recently reported that phthiocol (2-methyl-3-hydroxy-1, 4-naphthoquinone) possesses physical and chemical properties similar to pure vitamin K. Phthiocol was first isolated in 1933 by Anderson and Newman (3, 4) from the pigment of *Mycobacterium tuberculosis*, its synthesis was announced in 1934 (27). It has been shown by Almquist and Klose (2) that the antihemorrhagic activity of phthiocol lies between that of methyl naphthoquinone and hydroxy naphthoquinone. Their study indicated that the methyl group is functionally important, whereas the hydroxyl group seems to reduce activity. They concluded that the activity of phthiocol is lower than that of the more complex form of vitamin K existing in alfalfa, and Ansbacher and Fernholz expressed a similar opinion.

Recently, Thayer and his associates, MacCorquodale and his associates, and Fieser and his co-workers, have all reported tentative structural formulas for vitamins K_1 and K_2 .

Within a few months pure synthetic vitamin K probably will be available and, judging from present work, the one possible assurance

is as first suggested by Doisy (6) and his associates that a quinone structure will be found present.

Butt, Snell, and Osterberg (8) recently reported the clinical results in the treatment of 10 patients exhibiting hypoprothrombinemia. Phtholcol was administered to these patients. Nine of the 10 patients received either 25 or 50 milligrams of the material intravenously. 1 patient ingested 100 milligrams by mouth, together with 3 grams of bile salts. Following the administration of phtholcol there was a decrease in the elevated prothrombin clotting time for each of the 10 patients. The usual dosage was 50 milligrams in 250 cubic centimeters of sterile physiological saline. The clotting time for each of the 10 patients receiving phtholcol was reduced to normal. One patient had been bleeding. In this instance the hemorrhage was controlled. No untoward reactions were observed.

Snell and Butt recently reported the results of studies on naphthoquinone presenting antihemorrhagic activity.

While the work of Butt, Snell and Osterberg was in progress Smith, Ziffren, Owen, and Hoffman reported a case of obstructive jaundice in which the administration of phtholcol was followed by an elevation of the concentration of plasma prothrombin.

Clark, Dixon, Butt, and Snell have recently reported a series of 8 cases in which diseases of the gastro-intestinal tract prevented the absorption of sufficient quantities of bile salts and vitamin K and spontaneous hemorrhage ensued. In 4 of these cases in which prothrombin studies were made, elevation in the prothrombin clotting time was noted. In these cases the administration of vitamin K and bile salts reduced the prolonged prothrombin clotting time to normal.

It would appear justifiable to conclude that 4 basic factors seem to be necessary in the prevention and control of a deficiency in vitamin K: (1) the presence of bile of normal composition in the intestinal tract; (2) a liver which is physiologically capable of utilizing the vitamin; (3) a diet containing the vitamin itself or material from which it can be formed; and (4) a normal absorptive surface in the small intestine.

Bleeding esophageal varices. Bleeding from esophageal varices occurs as a complication of biliary cirrhosis. Such bleeding is usually sudden in onset and without warning and blood literally gushes from the patient's mouth. Such a hemorrhage, occurring in such sudden and unexpected fashion, is almost pathognomonic of ruptured esophageal varices secondary to cirrhosis of the liver. Not infrequently immediate transfusions of blood are necessary to replace the loss of blood. Later when the patient has recovered from the bleeding, studies of hepatic function by means of the bromsulfalein test will show considerable retention of dye in the blood and when the patient's condition permits the diagnosis frequently can be verified by roentgenological examination of the esophagus (Fig. 3).

The surgical treatment of bleeding esophageal varices which is worthy of consideration is ligation of the left coronary vein which lies in the gastrohepatic omentum. This treatment was suggested in 1929 by Walters, Rowntree and McIndoe (40) and it can be accomplished readily and without too great a risk by sectioning the gastrohepatic omentum as in the ligation of the gastric artery and vein in the performance of partial gastrectomy through which the branches of the left coronary vein go to the esophagus where they anastomose with branches of the internal mammary vein. In several instances this procedure has been performed. In others, splenectomy has been performed for the purpose of decreasing the amount of blood which ordinarily passes from the spleen into the portal vein (Fig. 4). Such a procedure also tends to decrease the amount of venous blood flowing through the esophageal varices from the venous tributaries between the splenic and gastric veins. Striking results have been obtained in several cases in which these procedures have been employed at the clinic, particularly in that group of cases in which cirrhosis of the liver was a part of Banti's disease.

HEMOPHILIA AND PSEUDOHEMOPHILIA

Although hemophilia and pseudohemophilia may be present among patients who have surgical lesions, the infrequency with which these 2 conditions are encountered at The Mayo



Fig 1 a, left, Pre-operative roentgenogram of stomach showing extensive lesion in the upper third portion. This patient had been treated elsewhere for anemia for 4 months

before the roentgenogram was made, b, postoperative roentgenogram following subtotal gastrectomy for carcinoma of the stomach

Clinic is emphasized by the fact that usually less than 4 hemophiliac patients are encountered each year, approximately the same number who have pseudohemophilia are encountered at the clinic. In commenting on the diagnosis of, and the differential diagnosis between hemophilia and pseudohemophilia, my colleague, Dr Charles H Watkins, writes as follows

"Hemophilia is usually readily diagnosed by the characteristic family history of hemorrhagic tendency confined to the male and transmitted by the female members of the family, by a history of frequent articular hemorrhages, prolonged hemorrhage from minor lacerations or following minor surgical procedures as dental extraction and tonsillectomy, and by absence of petechial hemorrhage

"The laboratory finding that is most characteristic is prolongation of the clotting time of the venous blood. The (Howell) prothrombin time is generally abnormally lengthened whereas the thrombocyte count is usually normal or slightly elevated, the bleeding time is within normal limits or slightly prolonged and the clot retracts if a clot is eventually formed. Examination of a stained blood smear shows no diagnostic change, there may be a secondary type of anemia, with increased regeneration of erythrocytes, and in cases of severe hemorrhage some immaturity of the myeloid cells may be present (Table I)

"The literature contains reports of conditions similar to, if not identical with, hemophilia which affected females. There is usually a familial tendency toward hemorrhage and the laboratory findings are those associated with a true hemophilia and in addition there is usually a slight to moderate de-

crease in the thrombocyte count. In most of these cases there has been no evidence of male hemophilia. Most authors regard this condition as female hemophilia, but do not feel that this disease is the same as male hemophilia

"Pseudohemophilia has been recognized for many years and more recently has been seen with increasing frequency. The condition affects both males and females and may be transmitted by either sex directly to sons and daughters. The features are recurrent hemorrhages from mucous membranes, uterus or gastro intestinal tract. Hemorrhage may be mild or severe, it occasionally may prove fatal but usually decreases (in severity) with advancing age. Purpura is not common. Laboratory findings consist of prolonged bleeding time, normal coagulating time and normal or high thrombocyte count. The prothrombin time and clot retraction time are usually normal but they may be prolonged and may vary considerably in the same case from time to time. It is probable that many cases grouped under this heading can be more definitely placed under specific types of blood dyscrasias with future research and greater understanding of the details of the mechanism of blood coagulation

"The treatment of hemophilia is often most discouraging. At present transfusion offers the most encouragement in all cases of serious or moderately serious hemorrhage. Local application of coagulating snake venom (that of the fer-de-lance or of Russell's viper) is of some value in control of localized hemorrhage, particularly application to the tooth socket after the extraction of a tooth or when the venom is applied directly to the bleeding lesion. In 1936, Timperley, Naish and Clark by the use of an extract of egg white were able to reduce the coagulation time and control hemorrhage in cases of hemophilia when the material was given intramuscularly or intravenously. They emphasized that this sub-



Fig. 2. Roentgenogram showing crater deformity of Meckel's diverticulum.



Fig. 3. Roentgenogram of bleeding esophageal varices. Inset, gastroscopic appearance of varices.

stance is not a cure for hemophilia as it merely controls hemorrhage and repeated injections of adequate amounts are required to do this.

Sango-stop, which consists principally of pectin, has been used with some success in the control of hemorrhage by Gohrbandt. The material may be used locally or given intramuscularly. In my experience this material had no apparent effect in controlling the hemorrhage during an acute exacerbation in two cases of hemophilia.

Patek and Tyler observed that cell-free normal plasma contained a substance which shortened the coagulation time of the blood in hemophilia. They have precipitated globulin from normal plasma which when suspended in saline solution was as effective as whole plasma in reducing the coagulation time. This same effect could not be obtained by the equivalent material from hemophilia plasma.

The value of this substance was emphasized recently in a case in which operation was performed by Harrington on a patient who had unsuspected pseudohemophilia. This patient, after an operation of radical amputation of the breast, had continuous bleeding from all raw surfaces, a bleeding which was unaffected by transfusions of blood but which was controlled immediately by the administration of plasma as previously described.

The use of various vitamin substances, Dr. Watkins continued, has not been proved of much clinical value although much investigative work has been and is still being carried out along this line. There is, however, evidence that placental extract may produce a reduction in the coagulation time. It is hoped that in the near future, as more research is carried out, some of these substances will become available but at present the most satisfactory and generally obtainable treatment is the local application of coagulating snake venom and repeated transfusion of blood.

PURPURA HAEMORRHAGICA

Purpura hemorrhagica, or essential thrombocytopenia, according to Dr. Watkins, is a disease characterized by hemorrhagic phenomena and by marked reduction of the number of platelets in the circulating blood. The chronic form of the disease (which is the most frequent and is of the most surgical significance) is characterized by cyclic periods of hemorrhage and spontaneous remissions, in the course of which there is complete freedom from symptoms. Usually at times, these cyclic periods of hemorrhage become more frequent and the hemorrhage becomes more severe than before.

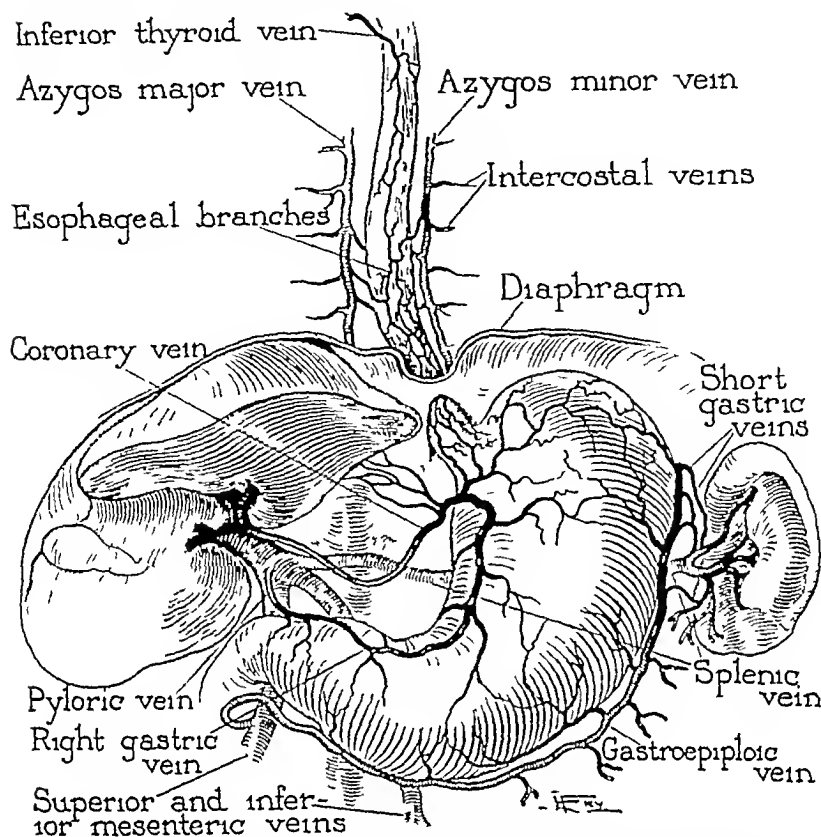


Fig 4 Drawing showing position of left coronary vein in the gastrohepatic omentum and the relationship of the circulation of the spleen to the stomach and liver

The laboratory observations show a reduction in the platelet count to 50,000 per cubic millimeter of blood or less. Although there is a prolongation of the bleeding time, the coagulation time of venous blood is usually normal.

The surgical treatment of chronic purpura hæmorrhagica is removal of the spleen. Removal of the spleen of patients having purpura hæmorrhagica is followed by immediate increase in platelets to normal and a decrease in and usually a cessation of the hemorrhagic episodes. In cases in which the disease is mild transfusions of blood often control the hemorrhagic tendency.

Numerous other purpuric phenomena may be confused with essential thrombocytopenic purpura, according to Watkins. Among these are the so called allergic types of purpura in which the patient frequently gives a definite history leading to identification of the precipi-

tating allergic factor and the condition reappears when the patient is exposed again to this factor. Some chemical substances, particularly those that have a tendency to damage the bone marrow, such as arsenic and benzol derivatives, may cause purpura.

Moccasin venom and large doses of vitamin C have been used with some success. These substances are worthy of trial, but if there is no improvement, splenectomy should be performed preferably and with greater safety during the period of remission.

APLASTIC ANEMIA AND ACUTE LEUCEMIA

Although aplastic anemia and acute leukemia are diseases in which the hemorrhagic tendency plays a rôle, their occurrence is very infrequent in surgical patients and treatment consists of the palliative administration of blood transfusions.

TABLE I.—FEATURES OF COAGULATION IN HEMORRHAGIC DISEASES
DIFFERENTIAL DIAGNOSIS*

Characteristics	Hemophilia	Purpura hemorrhagica	Aplastic anemia	Acute leukemia
Leucocyte count, total	Normal	Increased or normal	Profoundly decreased	Normal, increased or decreased
Leucocyte count, differential	Normal	Normal distribution, normal cells	Relative lymphocytosis	Immature cells, especially blast cells
Focus of regeneration of erythrocytes	Normal	Reticulocyte count usually increased, polychromatophilic and anisocytosis	Reticulocyte count low polychromatophilic and anisocytosis usually absent	Usually normal
Platelet count	Normal	Decreased	Decreased	Increased, normal, or decreased
Bleeding time	Normal or slightly prolonged	Prolonged	Prolonged	Normal or prolonged
Clotting time, serum blood	Prolonged	Normal	Normal or prolonged	Normal or prolonged
Retractility of clot	Normal, including phenomenon	Delayed or absent	Normal, delayed or absent	Normal, delayed or absent
Prothrombin time	Prolonged	Normal or prolonged	Normal or prolonged	May be prolonged
Thromboplastin test	Negative	Usually positive	Frequently positive	May be positive
Bleedability	Positive, occurs in males, transmitted by females	Little significance	No significance	No significance
Joint hemorrhages	Common	Rare	Rare	Rare
Protrusion and purpura	Rare	Common	Common	Not uncommon

*Table prepared by H. R. Glitt, M.D. and C. H. Watkins, M.D.

SUMMARY

The most frequent cause of gastro-intestinal bleeding is an ulcer of the posterior duodenal wall which perforates into the pancreas and erodes one of the branches of the gastroduodenal artery. Approximately two-thirds of the patients who have duodenal ulcer do not have hemorrhages as a result of it. If therefore one were to include this larger series of cases in a study undertaken to determine the incidence of fatal hemorrhage among patients having chronic duodenal ulcer the incidence would appear to be rather low. On the other hand, if one were to study the incidence of fatal hemorrhage among the 33 per cent of patients who do bleed the incidence would be found to be much higher varying from 4 per cent (Holman) to 40 per cent (Finsterer). The corollary of this is that the condition of the patient who has an acutely bleeding duodenal ulcer should be regarded as a surgical emergency and should be treated accordingly when necessary the hemorrhage should be controlled by opening the duodenum and suture ligating the gastroduodenal artery provided the condition of the patient permits.

Bleeding tumors of the stomach and colon, both benign and malignant, may cause continuous bleeding without gastro-intestinal symptoms. The presence of the anemia and its associated symptoms of weakness, dizziness, and faintness may be the only symptoms present.

Intestinal bleeding may occur as the result of an ulcer or a tumor of a Meckel's diverticulum.

It has been shown that there is a definite relationship between the concentration of prothrombin in the blood and the hemorrhagic tendency of jaundiced patients. The hemorrhagic tendency is the result of exclusion of bile acids from the intestinal tract and the absence of a hypothetical fat-soluble vitamin described as the coagulation vitamin or vitamin K. In the presence of such a tendency the prothrombin clotting time of the blood may be prolonged. By means of the oral administration of bile salts and vitamin K, a decrease in the prothrombin clotting time of the blood is obtained and bleeding ceases if it has been present. Almqvist and Klose recently reported that phtholocal a naphtho-

quinone, presented physical and chemical properties similar to those of pure vitamin K. Butt, Snell, and Osterberg recently reported the clinical results obtained in the treatment with phthiocol of 10 patients exhibiting hypoprothrombinemia. Each of the patients was thereby afforded a decrease in the elevated prothrombin time. Nine of the patients did not bleed, and one patient who had been bleeding ceased to bleed. Phthiocol can be administered intravenously by using 50 milligrams in 250 cubic centimeters of sterile physiological saline solution.

Bleeding from esophageal varices secondary to cirrhosis of the liver is sudden in onset and frequently occurs without premonitory symptoms. Immediate transfusions of blood, and later, ligation of the left coronary vein and possibly splenectomy, have produced satisfactory results in several instances, particularly those in which cirrhosis of the liver has been a part of Banti's disease.

Although hemophilia and pseudohemophilia occur infrequently, the latter may be unsuspected until bleeding from operated regions calls attention to the blood dyscrasia.

Cell free, normal plasma contains a substance which will shorten the coagulation time of the blood of patients who have hemophilia and this knowledge has been used successfully to stop the bleeding of such patients. Globulin can be precipitated from normal plasma which is equally as effective in controlling hemorrhage as cell free, normal plasma (29).

Purpura hemorrhagica, or essential thrombocytopenia, is characterized by hemorrhagic phenomena and by a marked reduction in the number of platelets in the blood, the surgical treatment of which consists in the removal of the spleen. This procedure should be done in the interval between hemorrhagic episodes.

Although aplastic anemia and acute leukemia are diseases in which the hemorrhagic tendency plays a role, their occurrence is infrequent among surgical patients. Treatment consists of the palliative administration of blood.

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CURRENT METHODS IN THE MANAGEMENT OF PEPTIC ULCER

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THE surgical treatment of peptic ulcer has by this time advanced well into what may be regarded as its third era. The first era was that of development and embraced approximately 25 years, from 1885 to 1910. During this developmental period the operations of gastro-enterostomy, gastroduodenostomy, gastric resection with its various methods of restoring gastro-intestinal continuity, and the several operations upon the pylorus and the first portion of the duodenum, designated as pyloroplasty, were developed and used in certain cases of peptic ulcer. The second era of gastroduodenal surgery was that of experience and included the years approximately from 1910 to 1930. During this period of experience much was learned of the normal gastroduodenal physiology, of the changes in gastroduodenal physiology in the presence of duodenal or gastric ulcer, and of the effects upon normal or disturbed physiology produced by the various operations devised and employed in the treatment of peptic ulcer. The vast experience of surgeons throughout the world in the surgical treatment of peptic ulcer has resulted in considerable unanimity of opinion, particularly so regarding the indications for surgical treatment in cases of peptic ulcer, and the purposes of surgical operations under the various circumstances. That unanimity of opinion does not exist among surgeons as to just the type of surgical procedure to be employed under certain circumstances emphasizes the well known fact that no single operation may be used routinely in every case, and that no operation, even though it seems to be the one best suited to the particular circumstances, is followed by the anticipated and highly desirable satisfactory result in every case. It would seem that the surgical profession has emerged from that second or stabilizing period of

gastroduodenal surgery and has advanced well into another era where by reason of its past experience it is well fortified with knowledge of the "how," the "why," the "whether," and the "when" of the various surgical procedures currently employed in the treatment of peptic ulcer.

The statement has been made by many that peptic ulcer is not a local disease, but is a local manifestation in the stomach or duodenum, or both, of a constitutional disturbance. Be that as it may, it is generally accepted that even though a definite constitutional disturbance is recognizable and may be definitely designated as such in many instances the treatment for the most part must be directed to the ulcer. Furthermore, whatever etiological relationship gastric acidity has to peptic ulcer it is well known that in general, whether the treatment is entirely by medical methods or by surgical intervention, the prospects of a permanent cure depend to a large extent upon the thoroughness with which the treatment or the operation controls gastric acidity and gastric secretion, either through dilution and neutralization or through quantitative reduction.

SURGICAL INDICATIONS IN PEPTIC ULCER

The results of careful, competent, medical management are eminently satisfactory in many cases of uncomplicated duodenal and gastric ulcer. This is particularly true in those instances in which the symptoms are of short duration, but it tends to become less true after chronicity has been established. The attitude of the clinician regarding the effectiveness of continued medical treatment, the degree of disability which the lesion provokes, and the surgical facilities and skill available, are all factors which determine the number of medical cures which the patient must experience after chronicity of the lesion has been established, or the number of symptomatic

uncomplicated recurrences he should endure under medical treatment before surgical consideration of the lesion may be entertained. What the results of medical treatment actually are has been most difficult to ascertain. Brown in 1930 reported the results of medical treatment in 1130 cases of peptic ulcer from his own services, those of the late Dr Sippy and associates at the Presbyterian Hospital in Chicago. He stated that 66 per cent of the patients were cured or greatly improved, 10 per cent obtained a fair medical result, and 13+ per cent had been operated upon subsequently elsewhere. While this study was based upon 1130 patients treated medically and 94 treated surgically, it was stated that 1900 patients had been treated but the subsequent course of events was not known in more than one third of the cases. St. John and Flood reported the results of medical treatment in 225 cases of duodenal ulcer in a recent review. All of the patients had been admitted to the hospital at one time or another and it was found that the incidence of recurrence in patients, who were accurately followed, varied from 65 per cent within the first 2 years of the follow-up period to 75 per cent in the patients who had been followed for more than 5 years. There was a mortality rate of 2.7 per cent in this selected group of patients during medical management. Among their conclusions these authors stated "the majority of patients with persistent pain lasting for more than 3 weeks during hospital treatment had an unsatisfactory course; also that surgical therapy should be considered for patients having multiple hemorrhages and persistent pyloric obstruction."

It is the consensus of opinion that surgical treatment of an uncomplicated peptic ulcer is indicated only after intractability to or impracticability of medical management has been proved and established, also that the complications of perforation, gastric retention and repeated massive hemorrhage constitute the important indications for surgical procedures.

Acute perforation of a duodenal or gastric ulcer constitutes a serious abdominal emergency usually characterized by such clinical manifestations that the urgency of surgical

intervention is immediately apparent. In the case of acute perforation of a peptic ulcer operation is performed as a life-saving measure and embraces only one objective—closure of the perforation. Although simple closure of the perforation does not provide the patient with assurance against recurrence, the surgeon's responsibility in the emergency is not that of a permanent cure of the ulcer. Experience has by this time proved very conclusively that usually a more extensive surgical procedure than closure of the perforation mitigates against recovery. Departure from the policy of simple closure of a perforation is seldom justified even though symptoms of ulcer recur in a large percentage of patients and secondary operation curative in purpose is often required. In spite of the fact that the time interval between perforation and surgical closure bears a distinct relation to the mortality rate of perforation, Roscoe Graham has deliberately prolonged this time interval in certain instances by as much as 8 hours for purposes of instituting pre-operative treatment of shock and secondary manifestations of the perforation with profit to the patient. He has recently reported 51 consecutive operations for perforated duodenal ulcer with but a single fatality.

Protective perforation of a duodenal or gastric ulcer occurs much more frequently than the acute perforation of an ulcer into the free peritoneal cavity. In many instances such perforation is characterized by clinical manifestations of a subacute inflammatory process. In others the perforation occurs insidiously by penetrating a structure to which, because of previous inflammatory episodes, the ulcer base has become attached. Resistance to medical treatment characterizes many of these lesions, and the type of pain in these cases of ulcer which penetrate the pancreas often leads to a clinical diagnosis of penetrating ulcer. That such protective perforation and penetration occur frequently has recently been brought to my attention following the review of the surgical findings and operations instituted in patients with duodenal and gastric ulcers upon whom I have operated during the past 15 years. Subacute or chronic perforation and penetration of nearby structures,

most frequently the pancreas, occurred in 120 cases or 13.8 per cent of 865 cases of duodenal ulcer, and in 32 per cent of 137 cases of gastric ulcer. The incidence of subacute or chronic perforation and penetration in the cases operated upon during the past 5 years has been 31 per cent in duodenal ulcer and 50 per cent in gastric ulcer. The higher incidence of this complication during recent years may be explained if it seems on the basis of a narrowing down of the indications for surgical treatment of peptic ulcer quite definitely to complications.

Gastric retention when due to the edema of reactivation of ulcer usually is temporary and subsides following medical treatment, but tends to recur. Persistence of gastric retention due to true cicatricial pyloric stenosis of a duodenal ulcer or to a disturbance of gastric motility in the presence of a gastric ulcer is amenable only to surgical treatment.

The bleeding peptic ulcer presents a serious problem to both the internist and the surgeon and usually the question arises as to whether medical management shall be relied upon or whether an operation shall be performed. It is a commonly held and frequently expressed opinion that hemorrhage is rarely a fatal complication in peptic ulcer and is best treated by non-surgical methods. It is well known that bleeding occurs in from 20 to 35 per cent of the cases of peptic ulcer. In many of the cases the bleeding is manifested through persistence of a secondary anemia and the presence of occult blood in the stool. As a rule these cases provide no serious problem because no emergency arises. Should healing of the ulcer not occur with resultant disappearance of blood from the stool and improvement in the blood picture following careful medical management, an operation of election may be necessary. It is the massive exsanguinating type of hemorrhage which constitutes a serious emergency.

Without bringing together all available data pertaining to the seriousness of the complication of hemorrhage from a peptic ulcer, the observations of Allen and Benedict, in Boston, and those of Goldman, in San Francisco, are particularly noteworthy. Death from exsanguination occurs in from 10 to 15 per cent of

patients who suffer massive hemorrhage from a peptic ulcer. These authors, among others, have emphasized the observation that the danger of a fatality rises rapidly with advancing age and is materially higher in patients beyond the age of 50 years than it is in younger individuals. Recovery from a massive hemorrhage offers no assurance that subsequent bleeding from a duodenal or gastric ulcer will not occur. Means has directed attention to the observation that as the mortality from massive hemorrhage increases with age, so, too, does it increase with each recurrence. There are now many internists and surgeons alike who subscribe to the following policy in the treatment of massive hemorrhage from a duodenal or gastric ulcer: (1) In the treatment of massive hemorrhage from peptic ulcer, whether primary or recurrent, one of the most important measures is transfusion for the purpose of restoring blood volume. (2) In the patient under 50 years of age operation seldom if ever is indicated during the hemorrhage. (3) Repetition of massive hemorrhage 2 or more times in patients under 50 years of age, warrants surgical intervention as soon as the patient's general condition will permit an operation of election with a maximum degree of safety. (4) In patients more than 50 years of age, operation is advised in those patients who show no improvement as the result of intermittent, repeated or continuous transfusion in from 12 to 24 hours. (5) In patients more than 50 years of age who have recovered from a massive hemorrhage through the employment of non-surgical measures, fate should not again be tempted, but surgical measures advised.

Acute massive hemorrhage from a peptic ulcer which is not subsiding is a most dramatic situation, and when matters proceed from bad to worse and bleeding continues under non-surgical treatment including the transfusion of blood, early surgical attack directly upon the bleeding lesion even though the hazards are great, may provide the only life-saving method. Surgical treatment during active hemorrhage from an ulcer embraces 2 important principles: that the operation be performed early, and that the operation be a direct one with excision of the bleeding lesion.

Finsterer Gordon Taylor and others have emphasized the importance of an early operation, one performed within 24 or 48 hours.

The problem of massive gastro-intestinal hemorrhage is frequently complicated by a lack of knowledge as to what the source of the bleeding may be. Those cases in which the diagnosis of peptic ulcer has not been established previously often provide considerable diagnostic difficulty through the inadvisability of employing the usual methods of diagnosis during or immediately following the hemorrhage. Likewise repeated massive gastro-intestinal hemorrhage may and does occur from other lesions of the tract. The futility of prolonged ulcer regimen and medical management for repeated massive hemorrhage has been observed on a number of occasions, when surgical exploration has disclosed that an ulcer in a Meckel's diverticulum or a benign tumor of the small intestine instead of an ulcer of the stomach or duodenum has been responsible for the bleeding.

In general the mortality rate following surgical intervention for massive hemorrhage from peptic ulcer has been greatly in excess of the mortality when treatment has been entirely by non surgical measures, because it has been the mortality of surgical procedures instituted late in the cases of medical failure and not the mortality rate of early surgical treatment in all cases of bleeding ulcer. Finsterer has recently reported only 3 deaths following gastric resection in 71 cases of bleeding ulcer a mortality rate of 4.3 per cent. Massive hemorrhage may be accepted as a distinct indication for surgical treatment, whether the operation is done at a time of election or as an emergency procedure during the hemorrhage, only on the basis that surgical skill and adeptness in the performance of the operation of gastric resection are available.

These general considerations apply to both duodenal and gastric ulcer as indications for surgical treatment. There is one more factor which must always be considered in gastric ulcer that is, the ulcer-carcinoma relationship. Reference is not made herein particularly to the question of malignant degeneration of a benign gastric ulcer but instead attention is directed to the difficulties often

encountered in differentiating by clinical and roentgenological evidence between a strictly benign gastric ulcer and an early carcinoma or a carcinomatous ulcer. Experience has proved that doubt may justly be cast upon many lesions exhibiting the clinical and roentgenological evidence of a gastric ulcer. When such doubt exists, the discerning clinician and the experienced roentgenologist through acquired wisdom, justly seek refuge in the diagnosis of a "lesion of the stomach" (Figs. 1, 2, 3 and 4). The therapeutic test in which clinical and roentgenological and, if necessary, gastroscopic observation is conducted for a period of 3 or 4 weeks during which time intensive medical treatment of the gastric lesion is carried out, has found a distinct place in the differential diagnosis of some of these gastric lesions. The value of the test is entirely dependent upon the competency of the interpretation which may be placed upon the observations, and faulty interpretation has in the past occurred too frequently. It should be borne in mind that temporary clinical improvement has often been noted following dietary and other forms of medical management of ulcer when instituted in a patient who harbors a gastric carcinoma. Also roentgenological and gastroscopic observations at repeated intervals are subject to error in interpretation even by competent observers in these respective fields. There is today unanimous opinion that when any doubt exists regarding the true nature of the lesion surgical treatment is indicated.

TYPES OF OPERATION

Surgical procedures for duodenal and gastric ulcer curative in purpose are of 3 general types (1) The indirect operations of gastro-enterostomy and gastroduodenostomy with or without excision of the ulcer (2) plastic operations on the pylorus with or without excision of the ulcer and (3) gastric resection with one method or another of restoring gastro-intestinal continuity.

Gastro-enterostomy has served in the past and so continues to serve the purposes of surgical treatment to best advantage in those cases of gastric retention due either to congenital pyloric stenosis secondary to chronic

duodenal ulcer, or to loss of gastric motility in certain cases of gastric ulcer and in other instances following local excision of a gastric ulcer. The results of gastro-enterostomy in the cases of true cicatricial pyloric stenosis of duodenal ulcer are the most brilliant in gastroduodenal surgery, from the standpoint not only of ultimate results, but also as pertains to mortality. However, experience by many has by this time proved quite conclusively that gastro-enterostomy may not be employed with similar success in other cases of duodenal ulcer and its complications. Mitigating against the results of gastro-enterostomy has been the frequency with which new ulcer occurs in or about the stoma. Gastrojejunal or jejunal ulcer has been reported to occur in from 17 to 24 per cent following gastro-enterostomy. However, the general average does not exceed 5 per cent. Judd and Hoerner, in reviewing a large series of gastrojejunal and jejunal ulcers, found that the symptoms appeared in 34 per cent of the cases within 6 months after gastro-enterostomy, and within 1 year in approximately 50 per cent of the cases. It is of interest that in many instances satisfactory results follow gastro-enterostomy for many years with subsequent development of a gastrojejunal or jejunal ulcer. Within the past 6 months C. G. Toland and I have each operated upon a patient at St. Vincent's Hospital for obstructing and bleeding gastrojejunal ulcer in each of which the gastro-enterostomy had been performed by the same surgeon in 1911 or 29 years ago. In one of these patients there was complete relief of symptoms following gastro-enterostomy for 17 years, and for 15 years in the other. Selinger has recently reported a case of acute perforation of a marginal ulcer occurring 30 years after posterior gastro-enterostomy. Variable as the incidence of gastrojejunal and jejunal ulcer may be, the new ulcer has proved to be of greater seriousness from the standpoint of complications and resistance to medical management as well as in the fact that the magnitude of the surgical procedures necessary is greater than that of the gastro-enterostomy employed for the relief of the original ulcer. Even though gastrojejunal and jejunal ulcers mitigate

against entirely satisfactory results following gastro-enterostomy, it should be borne in mind that no surgical procedure for duodenal ulcer provides complete assurance against a new or anastomotic ulcer and that gastro-enterostomy can be performed with little risk under certain circumstances in which the risk of any other operation might be great and not justified. Also, as an adjunct to conservative local excision of a gastric ulcer, gastro-enterostomy continues to be most useful.

Gastroduodenostomy has supplanted the simple Heinecke-Mikulicz type of pyloroplasty with its various modifications, and constitutes an operation whereby the purposes of operation for duodenal ulcer may often be served. The method of Finney and that of Judd facilitate excision of the ulcer when advisable, but neither procedure is applicable in all cases of duodenal ulcer. The lateral anastomosis of Jaboulay, so modified as to utilize the second and third portions of the duodenum, has a field of usefulness in certain cases of duodenal ulcer as a primary operation, fulfils many physiological requirements, and has been followed by few reported instances of anastomotic ulcer (Figs. 5, 6 and 7). Lateral gastroduodenostomy has likewise served a useful purpose as a conservative operation, instead of partial gastrectomy following the taking down of a gastro-enterostomy and excision of a gastrojejunal or jejunal ulcer. I have successfully employed lateral gastroduodenostomy instead of partial gastrectomy after taking down the gastro-enterostomy, closing the stomach, jejunum, and colon in 2 cases of gastrojejuno-colic fistula. Immediately after reporting entirely satisfactory results 6 months ago, in 22 cases of lateral gastroduodenostomy as a primary operation for duodenal ulcer and as an adjunct to taking down gastro-enterostomy and excising marginal or jejunal ulcers, I had occasion to perform the operation for gastrojejunal ulcer, which was followed immediately by symptoms of recurrent ulcer becoming progressively worse and finally exhibiting clinical manifestations of subacute perforation. Operation less than 3 months following the gastroduodenostomy disclosed a huge anastomotic ulcer which had perforated into the hepatic

flexure of the colon and resulted in a gastroduodenocolic fistula. The operation of partial gastrectomy and closure of the colonic fistula was not followed by recovery. Even though anastomotic ulcer following lateral gastroduodenostomy has also been reported by Wilkie Roscoe Graham and others, this operation still has a definite field of usefulness though limited.

Partial gastrectomy is applicable in many cases of gastric ulcer particularly in those instances in which the ulcer is situated in the pyloric half but in selecting a surgical procedure for gastric ulcer one should remain mindful of the safety of the operation and the excellent results which have followed local excision and posterior gastro-enterostomy in certain ulcers at or about the lesser curvature of the stomach. In my own experience in 137 patients with gastric ulcer upon whom I have operated, local excision and gastro-enterostomy was the operation employed in 40 per cent and partial gastrectomy in 43 patients or 31 per cent. In performing partial gastrectomy for gastric ulcer the safety of the operation is materially enhanced irrespective of the amount of stomach which is removed if the duodenum is avoided and the resection is limited distally by the pyloric ring. Because of the frequency with which a posterior anastomotic ulcer has followed the segmental so called sleeve resection with end-to-end anastomosis of the 2 segments this type of resection has become practically obsolete. In performing partial gastrectomy for peptic ulcer the magnitude of the reaction among other factors determines which one of the various types of gastro-intestinal restoration is most readily applicable, and of these the Pólya, Balfour Pólya, Billroth I and II and the various modifications of Finsterer Hofmeister and Haberer are those most frequently employed. The technical details of these procedures have been illustrated and described by Cutler and Zollinger and others.

Partial gastrectomy in the treatment of duodenal ulcer has advanced to an important position. Not all surgeons have subscribed to the operation with the enthusiasm of Berg Lewinohn and others, but many are employing partial gastrectomy much more often than

formerly in cases of duodenal ulcer. The frequency with which gastro-enterostomy and other conservative operations have failed to provide assurance against subsequent bleeding in the hemorrhagic duodenal ulcer has led to the generally accepted policy of instituting direct surgical attack upon the bleeding lesion and including excision of the ulcer as part of the surgical procedure. As Balfour has said, this is often most readily accomplished by partial duodenectomy and gastric resection. Likewise, in the ulcer which has perforated as a protective perforation, particularly in those instances in which the pancreas has been penetrated and a crater ulcer exists, experience has proved that partial gastrectomy facilitates either excision or exclusion of the lesion with eminently good results. It has been during the last few years only that I have subscribed to the idea of partial gastrectomy in duodenal ulcer and have employed the operation with increasing frequency approximately 30 per cent of the cases particularly in the hemorrhagic and in the penetrating ulcers.

Roscoe Graham stated before the Clinical Congress of the American College of Surgeons 2 years ago that partial gastrectomy had been performed in 131 or 53 per cent of 246 cases of duodenal ulcer operated upon with a mortality rate of 2.5 per cent. This is an enviable record but is misleading for in general the mortality rate of partial gastrectomy for duodenal ulcer as reported by others highly qualified in gastroduodenal surgery varies from 5 to 10 per cent. Many factors enter into the risk of partial gastrectomy for duodenal ulcer most important of which is whether partial duodenectomy with excision of the ulcer is included in the operation or whether the gastric resection is limited distally by the pylorus. The technical difficulties at times are great in performing partial duodenectomy and gastric resection in the case in which an ulcer of the posterior duodenal wall penetrates deeply into the head of the pancreas or when considerable inflammatory reaction results from subacute protective perforation of an ulcer. Even though resection provides greater certainty of cure and permanent relief of symptoms under such cir-



Fig 1 Large filling defect of a perforating lesion of the posterior gastric wall

cumstances than a more conservative operation, the price in terms of risk and mortality for this added certainty of cure is often too high



Fig 3 Filling defect showed questionable decrease in size during few weeks intensive treatment



Fig 2 Resected stomach (same case as Fig 1), huge benign ulcer penetrating body of pancreas

The failures following the various operations for duodenal ulcer are due for the most part to reactivation of the original ulcer or development of an anastomotic ulcer. Heuer's extensive review disclosed that the incidence of anastomotic ulcer following gastro-enterostomy varied from 0.9 to 6.9 per cent with an average of 3 per cent, also that jejunal or anastomotic ulcer followed partial gastrectomy in 0.6 to 6 per cent of the cases with an average incidence of 1.9 per cent. Finsterer reviewed his experience in 331 operations for recurrent or anastomotic ulcers before the Clinical Congress one year ago. He said that the mortality rate of secondary radical operation for gastrojejunal ulcer following gastro-enterostomy was 8.1 per cent as compared



Fig 4 Resected stomach (same case as Fig 3), lesion proved to be a carcinomatous ulcer

flexure of the duodenocolic fistula after gastrectomy as was not followed by anastomotic union after duodenostomy. Wilkie, Roscoe operation still is though limited.

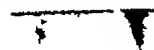
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Partial gastrectomy for duodenal ulcer has a position. Not all is to the operation with Lewisohn and other ing partial gastrectomy.



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 if you will be able to
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 next Monday. I will
 follow you. I will
 be with you.



(1) penetrating duodenal ulcers and in many instances satisfactorily accepted. Injections and gastric lavage and by and large the use of partial gastrectomy is great as in one case of indirect conservation of an anaesthetic following partial gastrectomy one half as great as in the other. In the surgical treatment of lower part of the stomach and part of the small intestine.

need as a routine procedure. Instead, that surgical procedure should be selected which most nearly meets the purpose of surgical intervention and which after a thorough survey of the situation upon opening the abdomen may be carried out with the maximum degree of safety.

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FOREIGN BODIES IN THE AIR AND FOOD PASSAGES

Observations on End Results in a Series of Nine Hundred Fifty Cases

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THE problems of diagnosis and treatment of foreign bodies in the air and food passages as viewed today should be considered recent additions to the field of medicine. Although no records are available, one may safely assume that foreign body accidents have occurred since the beginning of the human race. There are scattered references in early medical literature. In 1759 Louis read his *Memoir on Bronchotomy* before the Royal Academy of Surgery at Paris. He collected all of the cases of foreign body then known—28 in number—and presented all that had been learned concerning the subject up to that time. His work was outstanding and created favorable comment.

The first systematic study of this subject was made by Samuel D. Gross who published his *Practical Treatise on Foreign Bodies in the Air Passages* in 1854. This contribution still stands as a monument to the remarkable insight and keen powers of observation possessed by the medical men of his day. With the art of physical diagnosis in its infancy, the incandescent lamp unknown, the roentgen ray undiscovered, and no Chevalier Jackson to devise new tubes and forceps to solve mechanical problems, one can but express amazement that so many patients not only survived the procedures employed but also were restored to health. Gross was an outspoken advocate of bronchotomy or tracheotomy in the treatment of foreign bodies in the air passages, and he believed it should be resorted to the minute it is known that there is a foreign substance in the lung.

Weist's results led him to carry out a study of the methods of treatment for foreign bodies in the air passages particularly to determine if bronchotomy should be employed. On June

1, 1882, at a meeting of the American Surgical Association held in Philadelphia, he reported on a series of 1,000 cases of foreign bodies in the air passages. Briefly, in 63 cases the foreign body was removed by measures other than bronchotomy. Of the remaining 937 cases, 599 were not subjected to bronchotomy with 139 fatalities, a mortality rate of 23.2 per cent. Bronchotomy was performed in 338 cases with 93 deaths, or 27.4 per cent, a difference of over 4 per cent in favor of non-interference. Apart from his observations it is of interest to learn that 57 years ago the mortality rate in cases of recognized foreign bodies in the air passages was more than 24 per cent, and that attempts at removal by bronchotomy increased the mortality rate by over 4 per cent.

Foreign bodies in the esophagus were removed by employing a blunt metallic hook, esophageal forceps, a noose fashioned of wire, a sponge or piece of linen attached to the end of whalebone or a gum elastic catheter. Coins were removed with a coin catcher. The bone half probing, a miniature form of umbrella, was commonly employed. If the object could not be extracted, it was pushed into the stomach. Induced vomiting and the swallowing of bulky foods often were resorted to. In certain instances external incision was employed. There are no statistical references to failures or successes. It is presumed that these blind methods of removal frequently resulted in injury to the esophagus with fatal mediastinal infection.

In compiling data concerning end results in foreign body cases one is beset with many difficulties. Complications developing while a patient is under observation in the hospital may be recorded, immediate end results, namely recovery or death, can be reported. Accurate data on sequelae are secured however in a relatively small group. The reasons for this are the wide geographical distribution

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of patients, difficulty to evaluate data submitted, and failure to reach patients by accepted follow-up methods. In this series over 88 per cent were ward cases. The economic status of these patients was not conducive toward maintaining a settled place of abode.

A series of 950 consecutive cases of foreign bodies in the air and food passages removed by endoscopic means is reviewed from the standpoint of postoperative complications, sequelæ, and fatalities. No attempt shall be made to consider each class of foreign bodies separately or in detail. Certain factors influence results. Among these are the age of the patient, the character of the foreign body, its length of sojourn, its effects in the production of pathological changes, and previous attempts at removal. The location of the foreign bodies was recorded anatomically as follows: 413 in the air passages consisting of 19 in the larynx, 37 in the trachea, and 337 in the bronchi. In the food passages there were 537, divided as follows: hypopharynx 48, esophagus 457, and stomach 32.

Vegetal foreign bodies. The peanut still enjoys great popularity as a bronchial foreign body. Among 215 objects consisting of nuts, seeds, and shells there were 115 peanuts, 16 grains of corn (maize), 15 beans, 12 watermelon seeds, and 6 timothy heads as well as a great variety of other nuts, seeds, and shells. Of the 115 cases of peanut all but 4 occurred in patients under 10 years of age. Seventy-eight occurred in children, 3 years of age or less, the youngest being 9 months. The length of sojourn of the foreign body varied from a few hours to 6 months. In 19 cases the peanut was present from 1 to 6 months. Of the 100 cases of nuts, seeds, and shells other than peanuts, 15 occurred in patients under 1 year of age, the youngest being 8 months.

The cases of bean in the bronchus numbering 15 are noteworthy. Atelectasis was a common anatomical finding and was associated with severe laryngotracheobronchitis. All of the patients but one were from 13 months to 5 years of age. The incidence of tracheotomy and the mortality rate were higher in these than in any other group.

The cases of timothy head in the bronchus are of interest. Four patients were under 3

years of age. In 3 the length of sojourn was 21, 9, and 4 months, respectively. In these extensive suppurative changes had occurred. In 1 child, 8 months old, tracheotomy became necessary following bronchoscopic removal of the foreign body which had been aspirated 9 days previously. In 1 patient pyopneumothorax developed. Curiously, there were no fatalities.

Bones ranked next to vegetal foreign bodies in order of frequency. Of 166 cases, 19 were removed from the air passages and 147 from the food passages. It is of interest to note that bones in the bronchus commonly are overlooked and consequently are complicated with extensive suppurative changes. In 16 the sojourn of the foreign body varied from 1 month to 7 years. There were 2 deaths in this group occurring in children, 19 months and 2 years old, respectively.

Lodgment of bones in the food passages results from carelessness in the preparation of food and in eating. This accident is common in persons wearing dentures. Unlike bones in the airway, sojourn of bones in the food passages usually is relatively short due to the distress produced by constant swallowing efforts and injury to the esophageal wall. When one considers the character of the fragments swallowed, namely, irregular, jagged-edged, and sharp pointed objects, the thin esophageal wall, and the constant presence of infected mouth secretions, it is amazing that fatal complications are not more often encountered. In 2 patients complications developed which proved fatal.

Coins, discs, and buttons are common esophageal foreign bodies in children. Fortunately, the rounded edges produce little trauma so that complications resulting directly from the foreign body itself are uncommon. In this series there were 89 cases of coins and discs in the food passages and 2 in the air passages. Cases of buttons in the esophagus numbered 21. A majority occurred in small children and in over one-half the button was overlooked for periods varying from 1 to 9 months. In these there was marked peri-esophageal swelling with tracheal compression so that respiratory symptoms dominated the clinical picture (Fig. 1).

Dental objects Dentures usually are found as esophageal foreign bodies in adults while teeth commonly occur as bronchial foreign bodies and are more often observed in the young. Of 48 foreign bodies of dental origin 26 teeth, 3 fillings and 3 dentures were removed from the air passages and 16 dentures were removed from the esophagus. Teeth usually are contaminated with the bacterial flora of the mouth are often over looked and usually produce marked bronchial obstruction. As a result severe pulmonary infection is common. One fatality occurred in a child 22 months old following bronchoscopic removal.

Safety pins constitute the most difficult and potentially the most dangerous of all foreign bodies. With an occasional exception the pins are open with the point and keeper directed upward. A total of 97 safety pins was removed as follows from the air passages, 21 from the upper food passages, 65 and from the stomach, 11. A majority of the patients were infants and little children. In 9 instances of pins being removed from the air passages, the patients were under 5 years, the youngest being 3 months. Sixty-nine of the 76 safety pins removed from the food passages occurred in children under 7 years of age of which 47 were under 1 year. Two of these were 3 months and 5 were 4 months old. There was 1 fatal case.

In addition to these classes of foreign bodies there were aspirated many specimens of hard ware particularly tacks and screws, also beads, ammunition toys jewelry and other objects which usually produced partial or complete bronchial obstruction. There also were many irregular objects as jackstones hardware, toys, jewelry and other unclassified materials which lodged in the food passages producing obstruction and variable degrees of injury to the esophageal walls.

COMPLICATIONS AND SEQUELÆ OF FOREIGN BODIES IN THE AIR PASSAGES

Dyspnea Although occasionally observed in large, irregular esophageal foreign bodies producing tracheal compression, dyspnea more often occurred in foreign bodies in the air passages. It was observed most frequently in

cases of vegetal foreign bodies. Many of these substances set up a septic laryngotracheobronchitis in young children who constitute a majority of the vegetal foreign body cases. On the other hand metallic foreign bodies in the air passages rarely caused dyspnea unless there had been previous instrumentation.

Tracheotomy was performed for the relief of obstructive dyspnea and to aid in ridding the tracheobronchial tree of excessive secretions in 52 cases of foreign bodies in the air passages. This included 11 patients in whom tracheotomy had been performed prior to admission of the patient to the clinic. In 3 of these it was performed as an emergency measure before attempted removal of the foreign body. In 5 bronchoscopy had been performed and tracheotomy became necessary before admission while in the remaining 3 patients bronchoscopy had been done elsewhere and tracheotomy was performed as soon as the patients were admitted to the clinic. In 41 tracheotomy was necessary for relief of dyspnea which developed following endoscopic procedures performed at the clinic. Unsuccessful attempts at bronchoscopic removal had been made elsewhere in 10 patients before admission. Forty three of the 52 tracheotomies were performed in cases of vegetal foreign body. Of these 16 were cases of lodgment of peanuts, 27 were cases of nuts, seeds, and shells other than peanut and the remaining cases included a tooth a bone and metallic objects. It is of interest to note that tracheotomy was necessary in 10 of the 13 cases of bean in the bronchus while it was necessary in but 1 of 12 cases of watermelon seed.

Complications of tracheotomy Subcutaneous emphysema of varying degree occurred in a number of the patients, which was limited to the neck usually and cleared up promptly. Mediastinal emphysema following tracheotomy developed in 2 cases one aged 19 months, with a fragment of bone in a bronchus, the other aged 22 months, with a tooth in the bronchus. There was a brief interval between the bronchoscopy and the development of obstructive laryngeal dyspnea, and the emphysema did not develop until after tracheotomy. Therefore, it was the opinion



Fig 1 Roentgenogram of a child, aged 1 year, made on admission to bronchoscopic clinic 23 days after swallowing a button. There was cough, slight dyspnea with wheezing, and dysphagia for solid foods. A flat roentgenogram made on the day of the accident was negative for foreign body. A probang was passed with negative results. Roentgenogram after swallowing barium mixture revealed foreign body in esophagus, marked peri-esophageal swelling and forward displacement and compression of trachea. (Film by Dr W F Manges.)



Fig 3 Roentgenogram of man, aged 49 years, revealed an abscess cavity with fluid level in the lower lobe, left lung. There was cough and expectoration of fetid pus of several months' duration. Following bronchoscopic removal of fish bone patient recalled choking on a fish bone 10 months previously. (Film by Dr J T Farrell.)

that air entered the mediastinum from the tracheal opening. Both cases terminated fatally. In no patient did cellulitis of the neck



Fig 2 Roentgenogram made of a child, aged 4 years, 31 days after choking on a .22 calibre bullet. With the occurrence of fever 5 days after the accident a diagnosis of pneumonia was made. This did not run the usual course and a diagnosis of empyema was considered. Roentgenographic study of the chest revealed the foreign object. The bullet completely occluded the right bronchus distal to the orifice of the upper lobe bronchus, a. The cloudiness distal to the obstruction is due to atelectasis and drowned lung. Following bronchoscopic removal of the bullet, the lower lung cleared slowly, b. Prior to uncorking of bronchus temperature range was septic in type, this returned to normal after removal of bullet, c. A communication 11 years after removal indicated that the patient was free from respiratory symptoms and the lungs were normal.

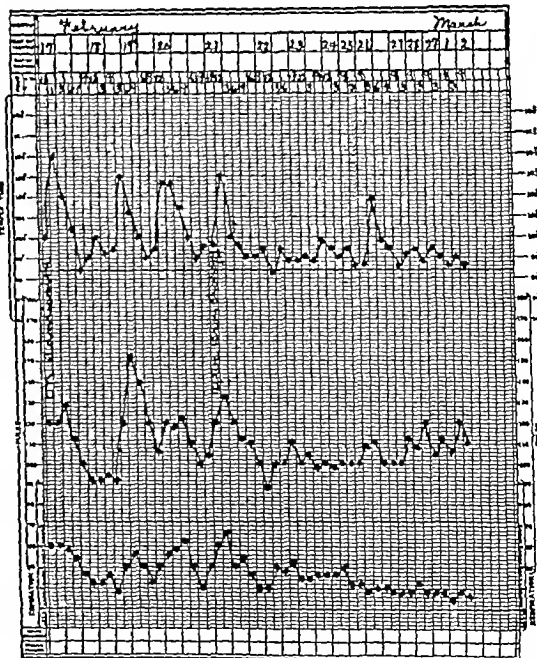


Fig 2c

develop. The tracheotomy wounds were allowed to remain unsutured and this undoubtedly accounted for the absence of serious infection. No unusual difficulties were encountered with decannulation.

Emphysema Extensive subcutaneous and mediastinal emphysema complicating bronchial foreign body and occurring prior to any endoscopic manipulation has been observed in 3 patients. In 2 the foreign body a peanut produced obstructive emphysema of the involved lung. There was no pneumothorax. In the third case a bean in the bronchus produced obstructive atelectasis of the entire right lung. There was marked emphysema of the neck and mediastinal tissues with a slight right-sided pneumothorax. All of these patients recovered following bronchoscopic removal of the foreign body although tracheotomy was performed in the case of bean in the bronchus for relief of obstructive laryngeal dyspnea following bronchoscopy.

Pulmonary abscess Abscess of the lung is an infrequent complication of foreign body in the air passages. Suppuration is common particularly in cases of long sojourn with marked bronchial obstruction. Retention of secretion distal to a foreign body with the development of drowned lung may present the clinical picture of pyothorax, atypical pneumonia, or pulmonary abscess (Fig. 2). Abscess based on the roentgenographic demonstration of a cavity in the lung with fluid level was observed in but one patient a bone in the bronchus aspirated 10 months previously (Fig. 3). The abscess healed following removal of the foreign body but moderate bronchiectasis still is present.

Pneumothorax The occurrence of pleurisy with effusion was observed in 3 patients. This cleared up spontaneously in 2 and aspiration was necessary in the third. The fluid was sterile. Pyothorax may develop in cases of pleural injury produced by a foreign body or in complete bronchial obstruction with extensive suppuration. It occurs most frequently following aspiration of grass heads. Two cases were observed in this series. In 1 a case of cocklebur in the right bronchus of 4 months duration, pyothorax developed and subsequently ruptured into a bronchus. Thoracot-

omy for drainage was performed and later the cocklebur was removed bronchoscopically. In the second case a timothy head had been aspirated. Pyothorax requiring thoracotomy developed within 2 weeks. The timothy head was removed by bronchoscopy 4 months later. Both of these patients recovered but undoubtedly bronchiectasis is present.

Bronchiectasis This is the most common as well as the most serious sequela of bronchial foreign body. Bronchial obstruction with retention and ultimately infection of bronchial secretions is an important factor in the etiology of bronchiectasis. Bronchial obstruction of varying degree is a fairly constant accompaniment of bronchial foreign body. While many cases are promptly diagnosed and the foreign body removed a relatively large group are overlooked for months, even years. Of the 413 aspirated foreign bodies, 357 were removed from a bronchus. These were studied from the standpoint of length of sojourn in the air passages. It was found that 105 almost 30 per cent were present for periods ranging from 1 month to 30 years. Of these, 44 were lodged from 1 to 3 months, 32 from 3 to 12 months, 16 from 1 to 5 years, and 10 from 5 to 30 years. In 3 the duration could not be ascertained.

It has been difficult to learn the ultimate fate of many of these patients. The remarkable improvement following bronchoscopic removal of the foreign body has led the patient and often the physician to misinterpret this as the beginning of complete recovery. Experience has shown however that a large number still exhibit symptoms and signs of chronic pulmonary suppuration. Only by roentgenographic study after instillation of iodized oil may a fairly accurate knowledge of the condition of the bronchi be obtained (Fig. 4). Experience also has taught that bronchoscopic removal of the foreign body particularly in the case of long sojourn usually is not adequate to insure complete recovery of the involved lung (Fig. 5). Repeated bronchoscopic aspiration of secretions, removal of granulations, and dilatation of strictures may be as necessary and important for complete recovery as removal of the foreign body itself (Fig. 6).



Fig. 4. Roentgenograms made in the case of a woman, aged 40 years, before removal of beef bone from the right bronchus (A) and after removal following insertion of a steel coil into the right lower lobe bronchus (B). The length of sojourn of the bone in the bronchus was 1 year. This patient was observed 3 years later and still as advanced bronchiectasis with cough, expectoration and evidences of cardiac embarrassment and pulmonary emphysema. Lobectomy could be performed but the patient is a poor material.

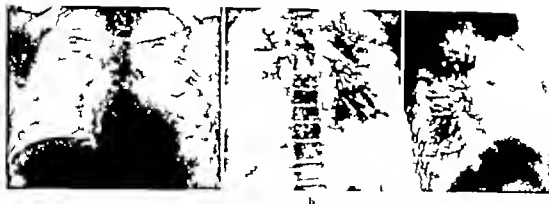


Fig. 5. Roentgenograms made in the case of boy aged 9 years who had aspirated piece of rubber years previously. Roentgenogram, a, made during March, 1916, immediately preceding bronchoscopic removal of the foreign body revealed marked increase in the pulmonary

markings particularly behind the heart shadow. b, After instillation of sodium oil into the left bronchus during July, 1916. c, All signs of bronchiectasis involving lower lobe of left lung as noted. Cough and expectoration of 4 to 6 ounces of pus daily. Lobectomy is contemplated.

CASE 6. Child, aged 1 year almond kernel in right main bronchus sojourn 6 days. Tracheotomy for dyspnea 36 hours after removal of foreign body. Death 7 days later from septic tracheobronchitis.

CASE 7. Child, aged 3 years grain of corn (maize) in trachea sojourn 7 days. Foreign body migratory, patient very dyspneic. Tracheotomy performed immediately following removal of foreign body. Developed scarlet fever 7 days later and died at Municipal Hospital on third day.

CASE 8. Child, aged 7 years fish bone in lower end of trachea sojourn 5 days. Unsuccessful bronchoscopy before admission. Tracheotomy for dyspnea on second day after removal of bone. Membranous exudate positive for *Bacillus diphtheriae*. Died on third day.

CASE 9. Child, aged 9 months bone in left main bronchus sojourn 6 days. Tracheotomy for dyspnea following removal of bone. Ten hours later developed marked subcutaneous and probably mediastinal emphysema and died within 4 hours.

CASE 10. Child, aged 22 months tooth migratory in trachea sojourn 8 days. Tracheotomy necessary for dyspnea 4 hours after bronchoscopy. About 4 hours developed subcutaneous and mediastinal emphysema and died in 4 hours.

CASE 11. Child, aged 1 month, open hearty plan in trachea sojourn 8 days. One unsuccessful bronchoscopy before admission. Marked dyspnea with cyanosis on admission necessitated immediate tracheotomy. Pin removed by bronchoscopy. Death occurred suddenly 26 hours later. At autopsy the



Fig. 6. a, Roentgenogram made of man, aged 35 years, revealed atelectasis of lower lobe right lung. There is history of severe choking attack and heezing respiration after eating lamb 33 days previously. Developed pneumonia (?) which, however, did not undergo resolution. Instead developed cough with expectoration of large quantity of foul sputum, eight loaves, 4 pounds, and pain in the right chest. At bronchoscopy portion of lamb bone

found completely occluding the right lower lobe bronchus as removed. b, Roentgenogram made 7 days after bronchoscopy revealed marked improvement in appearance of right lower lung. c, Roentgenogram made following instillation of sodium oil revealed moderate degree of bronchiectasis involving sublobar divisions of right lower lobe bronchus. Bronchoscopic treatments continued and patient practically symptom-free. (Films by Dr. K. Koralik.)



Fig 7 a, left, Roentgenogram of child, aged 2 years, 12 days after swallowing a jackstone. There is marked peri esophageal swelling, forward displacement of the trachea, and a suggestive air bubble immediately below the object. b, There is marked swelling of the retropharyngeal and retro-esophageal tissues with several small air bubbles. A retropharyngeal abscess was found and was drained through a perforation made by the jackstone. The patient made a very satisfactory recovery. (Films by Dr W F Manges)

cause of death could not be determined, inflammatory changes were noted in the tracheobronchial mucosa.

CASE 12 Child, aged 4 years, history of having aspirated a peanut which was removed bronchoscopically 1 week later. Tracheotomy performed following day. Two bronchoscopic aspirations later performed for removal of secretion. A roentgenographic study then made revealed bronchoscopic forceps blade in right lower lung. Unsuccessful attempt at removal made using improvised biplaned fluoroscope. On admission to clinic patient had right sided tension pneumothorax and was very ill. Believing forceps blade might be responsible for tension pneumothorax bronchoscopic removal with fluoroscopic aid was done. Patient died following day from pyopneumothorax and multiple abscesses of lower right lung.

Of the 12 fatalities 8 were aged 2 years or less, these included 3 under 1 year. A bronchoscopic attempt at removal was made in 5 cases and in 1 case 4 bronchoscopies and tracheotomy were performed before admission. In 11 cases tracheotomy was performed either before or after bronchoscopy for ob-

structive laryngeal dyspnea. Three of these were done before and 8 after admission. The causes of death were acute septic tracheobronchitis with pulmonary involvement in 5 cases, mediastinal emphysema following tracheotomy in 2 cases, scarlet fever and diphtheria, 1 each, pyopneumothorax and multiple pulmonary abscesses in 1, asphyxiation in another, and in 1 no cause could be demonstrated at autopsy.

COMPLICATIONS AND SEQUELÆ OF FOREIGN BODIES IN THE FOOD PASSAGES

Complications of foreign bodies in the food passages usually result from injury produced by the foreign body, ill-advised attempts at removal, instrumentation, infection following penetration of the wall of the food passages, or perforation of surrounding structures. Occasionally, compression of the trachea results in obstructive dyspnea and may necessitate tracheotomy.

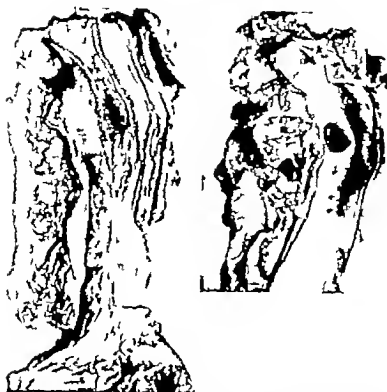


Fig. 8. Photographs of specimens of esophagus, a, left, and aorta, b, removed at autopsy by Dr. B. L. Crawford. The opening in the esophagus, as located opposite the bifurcation of the trachea. The margins of the opening were necrotic. The opening in the aorta appeared ragged in outline and measured .75 centimeters in diameter. It was located at the junction of the arch and descending portion of the aorta and communicated with the opening in the esophagus.

Tracheotomy. In 3 instances it became necessary to perform tracheotomy for relief of dyspnea. In 2 cases one of bone and one of jackstone in the esophagus it was necessary to do tracheotomy. Both terminated fatally and will be discussed under the heading of fatalities. In a third case a jackstone in the esophagus had penetrated the party wall. Tracheotomy was performed for relief of dyspnea before the foreign body could be removed. This case will be considered under esophagotracheal fistula.

Emphysema. This complication commonly results from a break in the mucosa due to injury produced either by the foreign body or from instrumentation. It was noted in 3 cases treated endoscopically. One of these was a fatal case of bone in the esophagus to be referred to under fatalities. The second was

one of toothplate in the cervical esophagus. The emphysema developed immediately following its removal. Whether it was the result of instrumentation or of previous injury by the denture could not be determined. The emphysema, limited to the neck, cleared promptly without untoward effects. In a third case emphysema of the neck developed prior to instrumentation. The patient, aged 36 years, had swallowed a large green olive 24 hours previously. It lodged in the cervical esophagus and provoked incessant gagging and retching. No additional emphysema occurred following removal of the olive and recovery was prompt.

Retropharyngeal abscess. Injury to the pharyngeal wall by foreign bodies and by well intentioned but misguided efforts at removal are common causes of cellulitis and abscess

of the retropharyngeal space. Digital attempts at removal of a swallowed or aspirated foreign body are ineffective almost always, often force the object into the larynx or hypopharynx, and frequently produce considerable tissue injury.

Many pointed objects as thumb tacks and safety pins lodging in the hypopharynx are complicated by retropharyngeal swelling. A majority of these undergo resolution without suppuration. In the cases of jackstone, several bones, and safety pins there was definite abscess formation which required incision and drainage (Fig. 7). One case terminated fatally.

Injury to the esophagus by foreign body. The wall of the esophagus may suffer superficial trauma by an irregular object, it may be penetrated by a jagged, foreign body or it may be perforated. These accidents may lead to superficial infection, abscess of the wall or of the peri-esophageal tissues, mediastinitis, and perforation into the trachea or great vessels.

Abscess of the esophagus and mediastinitis. The frequency of injury to the esophageal wall by jagged or pointed bones, open safety pins, dentures, and other irregular objects, and the continuous presence of mouth secretions should result in frequent peri-esophageal infection, mediastinitis, and death. The reverse, however, seems to be the case. This may be explained by the flexibility and elasticity of the esophageal walls, the protective barriers afforded by the peri-esophageal tissues in slowly perforating objects, and by drainage into the esophagus from the area of suppuration through the opening made by the foreign body.

It is not common to find a circumscribed abscess. However, one such case was observed.

CASE 13. A man, aged 53 years, had swallowed a pork bone 5 days previously. When admitted, he was very ill and complained of dysphagia and severe pain in the upper chest made worse by swallowing. Roentgenographic study revealed marked peri-esophageal swelling immediately below the level of the suprasternal notch. At esophagoscopy a spicule of bone, 5 centimeters in length, was removed. It was found transfixed across the esophageal lumen with the lowermost extremity imbedded in the lateral wall. When moved with forceps a large quantity of fetid pus was evacuated. The following day the temperature was normal and

the patient was symptom free. Subsequent studies revealed prompt clearing up of the infection and the patient made a complete recovery.

CASE 14. In a second case of bone the patient developed a retropharyngeal abscess and mediastinitis, required tracheotomy, and terminated fatally.

Esophago-tracheal fistula. Large irregular foreign bodies in the upper esophagus may ultimately, by pressure necrosis, break through the party wall and project into the trachea. One case was observed in this series.

CASE 15. A child, aged $3\frac{1}{2}$ years, swallowed a jackstone 32 days before admission to the clinic. Marked dyspnea and dysphagia were present. Roentgenographic study revealed a large jackstone in the upper esophagus. There was marked peri-esophageal swelling. One point of the jackstone, extending forward into the tracheal air column, apparently had penetrated the party wall. Esophagoscopic removal was attempted but owing to increasing dyspnea a 4 millimeter bronchoscope was passed and tracheotomy was performed. One point of the jackstone was observed projecting through the posterior tracheal wall in a mass of granulated tissue. The jackstone was removed esophagoscopically. There was remarkably little disturbance with swallowing, decannulation was carried out and ultimately the patient was discharged well.

Perforation of esophageal wall and great vessels. Three cases of perforation of the great vessels were observed in this series of cases. In one, a case of safety pin in the esophagus, the point of the pin had entered the innominate artery. In the second case, the sharp point of a fish bone had eroded through the wall of the aorta, and in the third case the point of a jackstone had entered a large vessel at the root of the neck. These cases will be described elsewhere. All terminated fatally.

Cicatricial stenosis resulting from foreign body. It is not uncommon to find an esophageal foreign body lodged proximally to a stricture. The development of cicatricial stenosis of the esophagus from lodgment of a foreign body has not been observed. In several instances, particularly in cases of prolonged sojourn of a button in a child, marked stenosis resulted due to inflammatory and edematous changes. With removal of the foreign body these cleared up promptly with no appreciable narrowing of the esophageal lumen.

Fatalities. In the series of 537 cases of foreign bodies in the food passages there were 4 deaths that could be attributed to the

foreign body. There were no fatalities following instrumentation for removal of the foreign bodies. A brief résumé of the cases follows:

CASE 6. A child, aged 3 months, jackstone in esophagus 1 level of suprasternal notch sojourn 24 days. Marked dyspnea on admission necessitated tracheotomy. Roentgenographic study showed tracheal compression. The condition as good following removal of foreign body until the eleventh day when there was a sudden outpouring of an enormous quantity of blood from mouth and nose. A *toupe* was permitted. It was believed that the bleeding was esophageal in origin probably from erosion of point of the jackstone into a large vessel. The tracheotomy wound appeared normal.

CASE 17. A child, 6 months open safety pin in upper thoracic esophagus lying obliquely with point 1 left and anteriorly and imbedded in esophageal wall sojourn 4 days. Removed by endogastric version with fluoroscopic aid. Patient discharged 3 days later. On the 11th day after removal the patient had profuse hemorrhage and died. At *toupe* depression was found in the esophagus which communicated with an opening in the innominate artery. The point of the pin apparently had penetrated the esophageal wall and entered the artery.

CASE 3. A man, aged 37 years, gill bone of cat fish in middle third of esophagus sojourn 8 days. On admission had marked dysphagia, severe pain in chest, and some dyspnea. Bone found with both extremities imbedded in esophageal wall marked inflammation and edema. The bone was removed and the patient died 36 hours later following profuse hemorrhage from mouth. At *toupe* a large necrotic area was found in the esophageal wall which communicated with an opening in the descending aorta (Fig. 8).

CASE 9. A woman, 65 years, multiple chicken bones in cervical esophagus sojourn 5 days. On admission she was found to have diabetes. There was marked dysphagia, dyspnea, partial asphyxiation of neck, and pain in chest. Four bones from neck of chicken removed from cervical esophagus. Tracheotomy was performed for dyspnea. The patient became comatose and died from retropharyngeal abscess, media tinitis, and bronchopneumonia.

Three of the fatalities resulted from penetration of the esophageal wall injury to one of the great vessels, and ultimately uncontrollable hemorrhage. Large, non-pointed objects as a jackstone may produce sufficient tissue destruction by pressure necrosis to accomplish this if continued for a sufficient time. Pointed objects may penetrate promptly if in close proximity to a pulsating vessel as in the case of the open safety pin and specule of bone.

Gastric foreign bodies. Included in the foreign bodies in the food passages are 32 which were removed from the stomach by rigid tube gastroscopy with roentgenoscopic assistance. There were no fatalities nor untoward developments. With few exceptions the patients were discharged within 2 days after removal of the foreign body. Included among the foreign bodies were 11 open safety pins, 5 bobette pins, 2 hair pins, and 8 coins. Of the safety pin cases, all were under 18 months of age, 10 being 1 year of age or less; the youngest was 2½ months. Twenty-five of the 32 patients were 3 years of age or less.

SUMMARY

A series of 950 cases of foreign bodies in the air and food passages is reviewed and complications and end-results are discussed.

Dyspnea occurred more often and tracheotomy was required more frequently in foreign bodies of vegetal origin.

Subcutaneous emphysema of the neck was observed not infrequently following tracheotomy. Subcutaneous and mediastinal emphysema may develop however before instrumentation or operation.

Pulmonary abscess is an uncommon complication of bronchial foreign body. Bronchiectasis, however, is often observed particularly in cases of foreign bodies of long sojourn and in complete bronchial obstruction with suppuration.

Unfavorable developments following esophageal foreign body lodgment are not as common relatively as in foreign bodies in the air passages. The common complications are injury to the esophageal wall with infection varying from traumatic esophagitis to mediastinitis. Fatal results also may occur from pressure necrosis and erosion into a large vessel or perforation of its wall.

In a series of 950 consecutive foreign bodies removed endoscopically from the air and food passages there were 6 deaths or 1.68 per cent.

In presenting this report I wish to express my personal appreciation and to pay tribute to that distinguished physician through whose life-long labors this type of work has been made possible who created a specialty in medicine and attained the highest degree of

skill and perfection in its practice, laid down the fundamental principles governing endoscopic procedures, devised a majority of the instruments and equipment employed, and by his writings and teachings has directly or indirectly taught all who are engaged in the practice of this specialty, Dr Chevalier Jackson, the Master Bronchoscopist

The foreign bodies and brief notes concerning each case in this series are on file in the Mutter Museum, College of Physicians of Philadelphia, under the designation of The Chevalier Jackson Collection

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WATER AND ELECTROLYTE BALANCE

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PROTOPLASM is a suspension of protein in salty water of definite composition. Tissue is a mass of units of protoplasm surrounded by spaces filled with salt solution. In contradistinction, fats and carbohydrates are stores of energy (40). In health these chemical relations are maintained with remarkable constancy through the metabolic reactions of the organism. In abnormal states of disease or inadequate intake of food elements these relations are disturbed and may of themselves cause untoward symptoms or even death. Frequently surgical patients are unable to eat and drink because of lesions of or operations on the gastro-intestinal tract and they likewise are subject to abnormal losses of fundamental substances and fluids consequently abnormalities of chemistry often require correction by the surgeon. The common acute, chemical emergencies in the surgical patient are caused by the loss or deprivation of oxygen, blood, water, salt and glucose. From early studies of metabolism, Robner stated that in starvation an animal can lose practically all of its glycogen and fat, half of its body protein, 40 per cent of its total body weight, and still live whereas the loss of 10 per cent of the water content results in serious disorder and the loss of from 20 to 22 per cent results in death. It is our purpose to present the problem of water and electrolyte balance in a manner applicable to the surgical patient by the clinician.

WATER BALANCE IN HEALTH

In Table I, the components of water balance in health are listed and the quantities stated show a nice adjustment between available water and excreted water. The balance at

first glance may seem to be too perfect, but this is exactly what happens, generally, not for a single day but over several days. The constancy of the body weight of many individuals for months and years is quite remarkable considering the ingestion and excretion of kilograms of material daily. Water drunk varies considerably, figures of from 800 to 2,000 cubic centimeters daily are common. Food often furnishes as much water as fluids drunk, there being 2 sources: (1) the water content and (2) the water formed by the oxidation of the constituent proteins, fats, and carbohydrates.

On the excretory side the low loss is in the stools, in which a fine example of body economy is illustrated, namely, that although from 8 to 10 liters of various fluids pour into the upper part of the gastro-intestinal tract daily, practically all of these fluids are absorbed lower down and barely enough remains to allow easy passage of fecal material. The two important water losses are for the excretion of waste materials in solution through the kidneys and by vaporization from the skin and lungs as part of the heat dissipating mechanism. Under comfortable environmental conditions approximately 75 per cent of the body heat is dissipated by radiation, conduction and convection from the body surface and 25 per cent by the vaporizing process (39). The latter is the safety valve in the control of body temperature for when there is more heat to dissipate because of physical exertion or fever or when the environment becomes hot and humid making radiation, conduction, and convection difficult, the vaporizing process becomes more active and dissipates more heat. In the extremes of temperature and humidity several liters of water may be vaporized daily. It is an important fact that the vaporizing process has "preferential rights" on available water over water for kidney function. The simplest illustration of this is the common ob-

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TABLE I — THE COMPONENTS OF WATER BALANCE IN HEALTH

Available water		Excreted water	
	c.cm.		c.cm.
Water drunk	1,200	Water of urine	1,200
Food, diet, or body substance			
Water content	1,000	Water of stool	100
Water of oxidation	300	Water vaporized	1,200
	<u>2,500</u>		<u>2,500</u>

servation in hot weather during which plenty of fluids are drunk, much sweating occurs, but little urine is voided

The kidneys are most important in maintaining the water balance. If there is plenty of available water, the urinary wastes are put out in a large volume of urine of moderate or low specific gravity. If water is scarce, the urine volume is small and its specific gravity is high. One should never forget the fact that a small volume of urine, particularly of high specific gravity, means insufficient available water.

WATER BALANCE IN DISEASE

The patient who can eat and drink should seldom be and rarely is a water balance problem, and by far his kind make up the majority of patients. The accusation has been made that too much emphasis has been placed on intravenous fluids. The emphasis, however, is right for the right patients, the intelligent surgeon never forgets that food and drink should be taken by mouth whenever possible. In some disease conditions nothing can be taken by mouth and under these circumstances about 300 to 500 cubic centimeters of water become available from the water content and the water of oxidation of body substance burned for energy requirements. This is inadequate for daily needs and unless fluids are given parenterally dehydration results, because water is being lost continually by vaporization and through the kidneys. At the University Hospital it is the custom to forget this internally provided 300 to 500 cubic centimeters and calculate the amount of fluid to meet the daily water needs for vaporization and for urine as follows: so many cubic centimeters for vaporization, and so many more for urine. The ideas as to these volumes are arrived at from the following considerations:

TABLE II — THE MINIMUM AMOUNT OF WATER NEEDED TO EXCRETE 35 GRAMS OF WASTE MATERIALS¹

Status of kidneys	Maximum concentrating ability	Minimum water needed
	Specific gravity	c.cm.
Normal	1.032 to 1.029	483
Diseased ²	1.028 to 1.025	595
	1.024 to 1.020	605
	1.019 to 1.015	850
	1.014 to 1.010	1439

¹Calculated from Lashmet and Newburgh.

²Chronic nephritis, pyelonephritis, renal tuberculosis, et cetera.

Water of vaporization for surgical patients who have no particular tax upon their heat dissipating mechanism, that is, patients who are in comfortable environmental conditions, who are not sweating, and whose progress is uncomplicated by fever or hyperthyroidism, varies from 1,000 to 1,500 cubic centimeters daily (8), which is approximately a normal amount (41). The 1,000 cubic centimeters is for the smaller, less active individuals, while the 1,500 cubic centimeters is for the larger, more vigorous persons. Patients whose course is complicated by an increased demand on the heat dissipating mechanism through fever, hyperthyroidism, or hot, humid weather vaporize more than the normal, and for these a minimum of 2,000 cubic centimeters daily is allowed as a starting figure (32). With the extremes of fever or hot, humid weather more water may be needed for this heat dissipating process.

The second important daily water loss, that of the urine output, can be controlled largely by the physician, for water given over and above the amount used for vaporization is excreted as urine. What is the minimum amount of urine below which one should be concerned, and what is a satisfactory urine output? Lashmet and Newburgh have furnished these data by determining the minimum amount of water needed by individuals with normal and diseased kidneys to excrete body wastes. From their work a calculation was made of the minimum amount of water needed to excrete 35 grams of waste material, which is about an average daily amount. This calculation is given in Table II, and from it one can see that about 500 cubic centimeters of urine a day is a minimum for the daily excretion of waste materials. It is not a satis-

TABLE III.—THE DAILY WATER REQUIREMENTS OF THE SURGICAL PATIENT

	c.c.m.	
Uncomplicated case		
Water for vaporization	,000 to	,500
Water for urine	,000 to	,000
	,000 to 1,500	
Complicated case: fever, hyperthyroidism, hot humid weather		
Water for vaporization	,000 to	,000
Water for urine	,000 to	,500
	1,000 to 1,500	

factory output of urine because it is only sufficient when the kidneys are working at their maximum concentrating capacity as shown by the specific gravity of the urine being close to 1.030. Also experience with several water balance problems have substantiated the view that when 500 cubic centimeters of urine with a specific gravity close to 1.030 are being put out daily the supply of available water is low and actually some patients with such a urine excretion may be dehydrating. We do know from the data of Table II that with volumes of urine appreciably below this amount, particularly when their specific gravity is low one can expect retention of waste materials as shown by an increasing blood non-protein nitrogen which results.

In round figures, 1,000 cubic centimeters daily is recommended as a good urine output for the majority of surgical patients. Wangenstein and his associates consider from 700 to 1,000 cubic centimeters satisfactory. White, Sweet, and Hurwitt (54) look for a urine output of from 800 to 1,000 cubic centimeters per day for neurosurgical patients, and Graham maintains a water balance in patients needing surgical procedures for gastric or duodenal ulcer that provides 900 cubic centimeters of urine daily. As can be seen from Table II these figures cover approximately twice the minimum volume and the upper brackets of diseased kidneys. For the seriously ill patient, particularly those with sepsis, with severe biliary tract disease or with some renal impairment from any cause a water intake that provides at least 1,500 cubic centimeters of urine daily is often desirable. For special reasons more urine may be needed.

The water requirements for vaporization and urine are summarized in Table III. The figures of from 2,000 to 2,500 cubic centimeters daily are ample for a great many patients who for one reason or another cannot take fluids by mouth. For those with complications, from 3,000 to 3,500 cubic centimeters daily may be necessary. In Table III the requirements are simply broken up into their component parts of so much for vaporization and so much for urine in order that one can deal with them independently according to the needs of the patient. For example Wassel in our laboratory showed that during hot, humid weather the vaporization loss in a group of general surgical patients amounted to from 2,068 to 3,034 cubic centimeters daily. It is quite apparent that if parenteral fluids were necessary for such patients, an allowance of 2,000 cubic centimeters for vaporization would fall short and water given for kidney function would be taken for vaporization the result would be an insufficient urine output. Variations, therefore, in the needs of patients under special conditions must always be kept in mind.

The kind of fluid to give if parenteral administration is necessary to provide water for vaporization and for urine is 5 or 10 per cent dextrose in distilled water. The reasons for this selection are based on studies which have shown that these solutions when administered intravenously at the rate of 300 to 500 cubic centimeters per hour are handled by the body the same as if they were given by mouth (7). Very little of the dextrose is spilled in the urine the majority is rapidly oxidized or stored as glycogen and the water of the solution becomes available for all purposes (55).

Is it safe to give only dextrose and water to some patients? This is a question often asked and which is not difficult to answer. Water given intravenously as 5 per cent dextrose in distilled water does not wash out appreciable amounts of sodium chloride through the kidneys (7) unless an excess of this electrolyte is present. So one does not need to fear appreciable losses of salt in this way. With vaporization there is little loss of salt in most surgical patients. But to provide for these minor elec-

trolyte losses, it is our custom to give 500 cubic centimeters of Ringer's solution daily to patients whose chief need is water for vaporization and water for urine, and who are receiving dextrose solution in water for that purpose.

Abnormal losses of fluid from the body, such as by vomiting, are common among seriously ill surgical patients, and result in both a loss of water and the substances in solution in that water. Among the latter, the electrolytes are very important and the chief of these is sodium chloride. An understanding of sodium chloride metabolism, how it is affected in surgical disorders, and its management in such conditions is necessary. Recently, a comprehensive survey of the salt balance in surgical patients was made by Nadler and by our associates, Bartlett, Bingham and Pedersen.

NORMAL METABOLISM OF SODIUM CHLORIDE

The importance of sodium chloride to the body is well illustrated in Figure 1, where the central diagrams of Gamble (17) show the predominance of sodium as the chief base and chloride ions as the chief acid radicals in the composition of the blood plasma and interstitial fluid. In cellular fluid these places are taken by potassium and phosphates. Sodium chloride in the extracellular fluids serves 2 vital functions: (1) it helps to maintain the acid-base balance of the body, and (2) it is largely responsible for the osmotic pressure of the various fluids. The total amount of electrolytes present is importantly concerned with the maintenance of the normal volume of extracellular fluid, since it is a fundamental axiom that the body keeps its substances in solution at approximately a constant concentration. Sodium has a greater rôle than chloride ions in the maintenance of the extracellular fluid volume (18), since the latter can be replaced by bicarbonate made up from the carbon dioxide of catabolism, while there is no substance to take the place of sodium. If sodium is depleted, water must be lost to keep the concentration of the substances in solution at the normal level. Dehydration thus follows sodium depletion more than chloride loss.

Figure 1 also shows diagrammatically the normal metabolism of sodium chloride. From

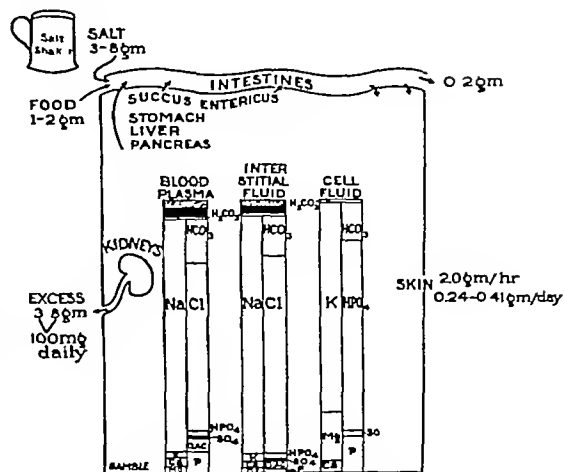


Fig 1 A diagrammatic presentation of sodium chloride metabolism

the total intake of 3 to 10 grams daily the largest portion comes from the vigorous use of the salt shaker as taste demands, the natural content of sodium chloride in the food is not much more than 1 to 2 grams per day (43). Along with this oral intake of salt the upper part of the gastro-intestinal tract receives through saliva, gastric juice, succus entericus, bile, and pancreatic juice about 8 to 10 liters of salt containing fluids daily. This is another remarkable example of body economy, namely, similar to the conservation of water practically all of the salt is later absorbed, the sodium chloride loss in the stool is reported at about 0.2 grams per day (51). The loss of salt from the skin is variable. With insensible perspiration Freyberg and Grant found values from 0.25 to 0.41 gram per day, which are negligible. With active sweating more salt is lost (14), upper limits under extremes of work, heat, and humidity are reported as high as 2.0 grams per hour (37). The kidneys excrete the excess sodium chloride remaining after the stool and skin losses have been deducted from the oral intake. In this way the normal sodium chloride balance is maintained.

At this point it should be understood that while the kidneys normally excrete the excess of salt, they conserve salt and excrete meager amounts, as low as 0.1 gram per day when there is no excess, or even a deficit because of an abnormal loss of salt as by vomiting.

Benedict followed the chloride excretion in the urine of a subject fasting for 31 days and found that 12.3 grams of chlorine or 20.3 grams of sodium chloride were put out during that time. Half of this amount, however was put out in the first 4 days during the later days only traces of chloride in the urine could be shown. This same protection of the electrolytes when the intake is insufficient has been observed by many workers (52, 53, 19). It applies to individual ions, and their conservation or excretion according to needs is an important function of the kidney.

The total amount of sodium chloride in the body has been estimated by various investigators. Calculating on the basis of a 60 kilogram man the figures of Magnus-Levy give a total sodium chloride content of 121.7 grams; those of Lotka, 158.4 grams; White and Bridge (52) 150 grams; and Sherman, 148.8 grams.

ABNORMAL SALT LOSSES

The sodium chloride metabolism of seriously ill patients may be profoundly affected. For various reasons there may be no intake of water or food by mouth, so that no new salt becomes available. To make matters worse there may be abnormal losses of salt from the body and of all such channels, vomiting and diarrhea are by far the most common. Less often drainage from the intestinal and biliary tract through tubes and fistulae, copious wound secretions, withdrawal of considerable volumes of ascitic fluid, and prolonged sweating carry away important amounts of water and electrolytes. Gamble and his associates have shown that the gastro-intestinal secretions have essentially the same electrolyte materials, but with some differences in their various concentrations. Since the losses from the gastro-intestinal tract are most important in dealing with surgical patients, it is imperative to know more about these differences that exist when fluid is lost from different portions of the tract, and how these losses are reflected in the two blood chemistry tests commonly carried out.

Chloride loss is shown by plasma chloride determinations: the normal value as expressed in the commonly accepted terms of sodium

chloride is 560 to 630 milligrams per 100 cubic centimeters (43). For our calculations the lower limit of 560 milligrams per 100 cubic centimeters is used. Sodium loss or total base loss is impractical to determine directly because the chemical procedure is too time consuming. As a substitute a fair indication of total base concentration is obtained from a measurement of the plasma carbon dioxide combining power which shows the amount of base in excess of strong acid or for practical purposes, the amount of sodium in excess of chloride ions. There is practically always an excess of base and the normal value of the carbon dioxide combining power is 55 to 65 volumes per cent (43). If chloride is lost in excess of sodium, with more base remaining, the plasma carbon dioxide combining power is elevated 75 or more volumes per cent, and a condition of alkalosis exists. If sodium is lost in excess of chloride, with the base having the greatest reduction, the plasma carbon dioxide combining power is lowered to 50 or less volumes per cent, and a condition of inorganic acidosis is present. It is important to remember that the plasma carbon dioxide combining power is a measurement of the base concentration relative to the acid concentration at the time of the test. A normal or even an increased plasma carbon dioxide combining power obtained when plasma chlorides are materially lowered indicates that some sodium has also been lost. An important practical point which will be stressed later is that fluid lost by vomiting or by removal through suction from the upper part of the gastro-intestinal tract usually carries with it a loss of chlorides greater than and rarely equalled by the loss of sodium. A calculation, then of the proper amount of saline solution to give on the basis of the chloride loss for practical purposes provides for the sodium loss as well.

In Figure 2 a schematic presentation is given of the fluid from various portions of the gastro-intestinal tract and its acid or base predominance. The causes for the loss of such fluid and its effect on the plasma chloride and carbon dioxide combining power are discussed briefly as follows.

Pyloric obstruction. Obstructing lesions of the pylorus in infants are commonly the result

of congenital hypertrophic stenosis and in adults are due usually to carcinoma of the stomach or scar contraction from long-standing peptic ulcer. The fluid loss is predominantly acid. The result is a lowered plasma chloride and a relative increase in plasma base as shown by an increase in the carbon dioxide combining power of the blood. Here one has an opportunity to see the typical picture of alkalosis.

Bile drainage Surgical drainage of the common bile duct often leads to the loss of several hundred cubic centimeters of bile a day, with a consequent greater loss of base than acid ions. Generally the drainage is insufficient for serious depletion of electrolytes, but occasionally it is, and one finds a slight to moderate reduction in plasma chlorides and a somewhat greater depletion of base as shown by a lowered plasma carbon dioxide combining power. The loss of several liters of bile for several days will result in severe electrolyte depletion, and because the sodium loss is great the dehydration also will be great.

Duodenal or jejunal obstruction The vomiting of fluid from even as low down as the mid-ileum results in the loss of a complex fluid containing saliva, gastric juice, bile, pancreatic juice, and succus entericus. As can be seen in Figure 2, some of these fluids have more chloride than base while others have more base than chloride. The sum is a loss of about equal amounts of chloride and base, so chemistry studies usually show a reduced plasma chloride and a nearly normal plasma carbon dioxide combining power which, being relative to the chloride concentration at time of test, indicates a lowered amount of base.

Ileostomy drainage Here base loss predominates and with considerable semi-fluid or fecal drainage or with moderate drainage for many days one finds a slight to moderate reduction in plasma chlorides and a considerably lowered plasma carbon dioxide combining power. Such drainage is a common cause of inorganic acidosis in surgical patients, and since the chemical disturbance may be quite marked, patients with an ileostomy require close supervision. Recently this matter has been well presented by Welch, Masson and Wakefield.

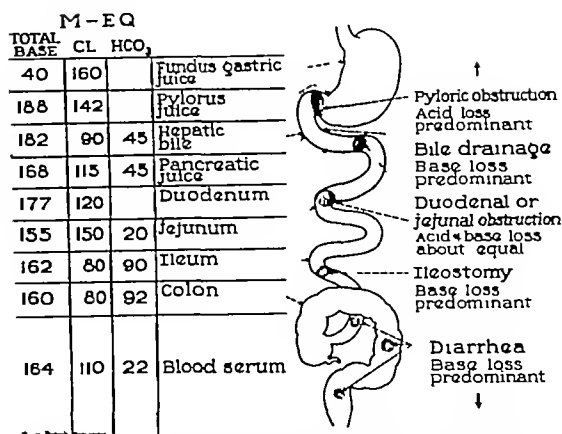


Fig 2 A schematic presentation of the fluid from various portions of the gastro-intestinal tract and its acid or base predominance

Diarrhea The tremendous loss of body fluid and substance which can result from diarrhea and dysentery has been recognized for many centuries, and O'Shaughnessy, in 1832, knew that the effluvia was alkaline and its loss reduced the body base. The pediatricians have been particularly concerned with this problem and the chemical studies in this regard by Gamble and his associates (17) are of fundamental importance. Because of the extra base loss, Hartmann has advocated the use of sodium lactate solutions, which, since the lactate is oxidized, provides an excess of base. Diarrhea and dysentery are not commonly associated with surgical lesions, so they will not be discussed further in this paper.

It would seem that correction of all these different fluid losses with their variations in the amount of base or acid present would be most complicated and difficult. Gamble (17), however, has emphasized the fact that whether an alkalosis or inorganic acidosis is present both can be corrected by a combination of the same two solutions: (1) isotonic saline solution which provides water and the chief electrolytes needed, and (2) dextrose solution which provides an excess of readily available water for kidney function. Whether more chloride is needed than sodium or vice versa, the kidneys with a good supply of water can be depended upon to use this water for the excretion of the less needed electrolyte. The

TABLE IV—THE EXCELLENT EXCRETION OF AN EXCESSIVE INTAKE OF SODIUM CHLORIDE BY A NORMAL ADULT MALE

24 hour period of study	Body weight kg	Sodium chloride intake Kemper's solution			Sodium chloride in urine gm.	Plasma chloride mg. per cent	Plasma carbon dioxide combining power volume per cent
		diet gm.	solution gm.	total gm.			
	30					343	30
	30.6		22.6		11	348	31
	30.2					343	31
Total		1.2	22.6	23.8	20.2		

Interplay of these two solutions, one providing the water and the electrolytes needed to correct dehydration and the other adequate water for kidney function is most important.

The discussion of abnormal salt loss firmly establishes the reasons for the administration of saline solution to some patients. Past experience reveals that generally too much salt solution has been given without regard to whether sodium chloride is needed or not. Such thoughtless treatment is harmful and the whole subject of excessive salt intake needs thorough understanding.

EXCESSIVE SALT INTAKE

An important step encouraging the use of intravenous fluids was the demonstrated value of saline solution as a life saving measure for animals with intestinal obstruction. The investigations of O'Shaughnessy, Hartwell and Hogue, MacCallum and his associates, Haden and Orr, Gamble and Ross (18) and many others (2) definitely established the value of saline solutions for patients who have lost appreciable amounts of body electrolytes. The tendency after this work, however was to

give salt solution to all patients needing fluids parenterally whether they had lost salt or not. This procedure results many times in the administration of excessive amounts of sodium chloride, and an understanding of its handling by various types of individuals is important.

Excessive amounts of salt in normal individuals. Normal individuals can handle 35 to 40 grams of sodium chloride daily without apparent difficulty for the kidneys are able to excrete the salt in urine in concentrations up to 2 per cent (43). In Table IV this is demonstrated by the data from excessive salt administration to one of our normal subjects. Note that there was no retention of water as shown by no change in weight, that 30.3 grams of the 34.1 grams of salt ingested in the 2 days were excreted in the urine, and that the plasma chloride and carbon dioxide combining power were essentially unchanged.

Excessive amounts of salt to patients in good general condition. There are many patients in this category who receive fluids parenterally for a day or two after an operation because they are upset for one reason or another and cannot take fluids by mouth. They are healthy

TABLE V—THE SATISFACTORY EXCRETION OF AN EXCESSIVE INTAKE OF SODIUM CHLORIDE BY A PATIENT IN GOOD GENERAL CONDITION

24 hour period of study	Body weight kg	Sodium chloride intake from physiological saline solution gm.	Sodium chloride in urine gm.	Plasma chloride mEq. per cent	Plasma carbon dioxide combining power volume per cent
	66			369	37
	66	27.8			
	66	26	20		
	67			365	35
Total		53.8	20.0		

*Study began 160 hours after the operative repair of left inguinal hernia.

except for some local lesion before their operation and are essentially healthy after the operation. Their ability to handle excessive amounts of sodium chloride almost as well as does the normal subject is shown by the data in Table V in which an adult male in 3 immediate postoperative 24 hour periods was able to excrete 52.9 grams out of 69.1 grams of sodium chloride given. The possible dangers of saline solution are not apparent in this group, but the choice of salt solution for them is a poor one. There is no particular value in saline solution when sodium chloride is not needed, and the kidneys of these patients have the extra load of excreting the excess salt. If nothing can be taken by mouth, what this group of patients chiefly requires parenterally is water and some carbohydrate, which is provided by dextrose solution in water.

Excessive amounts of salt in the sick surgical patient. Matas, in 1924, published one of the earliest papers on intravenous therapy in this country and pointed out that large amounts of salt solution may do harm, may produce degenerative changes in heart muscle and kidneys, and may cause edema of the lungs. In 1933, Jones and Eaton (24) stressed this point further by a review of 34 cases of subcutaneous edema seen after operation. Five of their patients also had edema of the lungs, and 1 died from obstruction due to edematous closure of a gastro-enterostomy stoma. Twenty-one of the 34 patients in the series had lesions of the gastro-intestinal tract such as peptic ulcer, gastric malignancy, or perforated appendix. In the production of the edema a low serum protein consequent to undernutrition was considered to be most important, while other factors were the administration of excessive amounts of fluid and salt, profuse surgical drainage, the general effects of sepsis, the loss of serum protein by massive hemorrhage, and a retention of base due to temporary disturbance of renal function. Jones, Eaton, and White (25) later produced experimental edema in cats, substantiated the importance of the above factors in its production, and added those of major surgical procedures and general anesthesia. These factors leading to retention of water will be mentioned again later.

Intravenous fluids are commonly used for patients with shock and there is every need for their selection on the basis of results. Beard and Blalock studied the composition of the blood of dogs undergoing continuous trauma to the intestines (1) when no fluid was injected, and (2) when fluid was injected continuously. A copious weeping of fluid from the peritoneal surface resulted from the trauma. This fluid had the same protein content as that of the blood plasma and the result was a loss of plasma proteins, and, therefore, a diminished osmotic pressure of the blood. The effects of the injection of various fluids on the reduced protein content of the blood of these dogs, which were in shock, are most important. With the continuous injection of 0.9 per cent salt solution there was a decrease in the total volume of blood plasma and a marked reduction in the percentage of protein per unit volume of serum, the calculated entire amount of protein in the blood stream was generally one-half of the original values. It was the impression of Beard and Blalock that if the injection of salt solution was stopped the blood pressure of the animals fell more rapidly than if no intravenous fluid had been given. The results were no better with 3.0 and 6.0 per cent saline solution. From these experiments one can expect little from the treatment of moderate or severe shock due to blood plasma loss by the use of physiological saline solution. Beard and Blalock state "that they do not wish to imply that if a patient is in shock as a result of an injury and no donor is available that saline or similar solutions should not be injected. However, in the absence of a favorable response in blood pressure after a considerable amount of solution had been injected, almost certainly the further administration of the same fluid intravenously would diminish the chances of recovery."

A further warning against the excessive administration of salt solution to seriously ill surgical patients comes from the study of White, Sweet, and Hurwitt (54) on the water balance of neurosurgical patients, a study which was carried out in order to be able to maintain such patients in a slightly dehydrated condition and thus avoid edema of the

TABLE VI.—DATA ILLUSTRATING THE DIFFERENCE IN THE ABILITY OF A PATIENT TO EXCRETE AN EXCESSIVE INTAKE OF SODIUM CHLORIDE WHEN IN POOR GENERAL CONDITION BECAUSE OF SEPSIS AND LATER WHEN WELL.

Date	Patient Sepsis					
	Physiological saline solution intravenously		Output urine		Body weight	
November	ccm.	gm. NaCl	ccm.	gm. NaCl	64.6 kg.	Change
	2690	6.5	730		67	+2.7
26	2992	27	1,264	13	63	-1.3
Total	5682	33.5	1,994	13		+1.4

Patient Well						
December					kg.	
13	2973	23.6	2,276	22	64.7	-1
29	2,677	29.6	2,941	24.6	64	-1
Total	5,650	53.2	5,217	46.6		-2

S. G. Age 30. Admitted Nov. 24 with acute suppurative otitis media. Fever to 101.6 degrees F. Given 100 cc. 5 per cent glucose in physiological saline solution when septic and later when well.

brain. They state that "edema from too much salt solution is a very real danger. For this reason we recommend limiting the use of glucose in saline to the period of operation, during which there is a considerable loss of sodium chloride. Thereafter fluids can usually be taken by mouth in adequate volume by neurosurgical patients. Saline solution should only be used when serum electrolytes are seriously depleted by prolonged vomiting or diarrhea, and then in limited amounts. In summary they state "Postoperatively fluid must be replaced much more accurately in neurosurgical than in general surgical patients. While the latter may be given a moderate excess of fluid with impunity, a slightly deficient state of hydration is safer after operation on the brain in order to minimize cerebral edema. In the absence of vomiting or diarrhea, five per cent glucose in distilled water appears to be a better solution for prolonged intravenous medication than when combined with normal saline because the addition of saline increases the risk of edema. This is sound advice and has wide application considering the great number of craniocerebral injuries now due to automobile accidents.

The case with which salt solution is retained by the sick surgical patient was further demonstrated by Collier, Dick and Maddock (7) who selected such a group of patients and gave them daily by the intravenous route about

3,500 cubic centimeters of 5 per cent dextrose in either physiological saline solution or Ringier's solution. Twelve of the 13 patients in the series retained water and gained weight although they were receiving insufficient calories and should have lost weight. One patient gained 7.5 kilograms and showed edema of the dependent parts. Only 3 of the 13 patients in the series had plasma proteins down to the critical level of Moore and Van Slyke at which edema is likely to appear. In contradistinction to the normal subject and the patient in good general condition, the sick surgical patient is less able to excrete the excess sodium chloride given but adds it with water to his body fluids. This difference between the sick and the well patient reaction is shown in Table VI in which the same patient with approximately the same intake of salt on the 2 occasions retains most of it with water and gains weight when he is sick because of sepsis, and later is able to excrete most of it and does not retain water when he is well.

It is important to emphasize that the sick surgical patient is the patient with the factors which have been pointed out by Jones and Eaton (24) and others (5, 7, 10, 35, 50) as setting the background for the development of edema, namely nitrogen starvation with its consequent low serum protein, general malnutrition, sepsis in all its aspects, hemorrhage, profuse serous drainage, renal, and hepatic

The first of these is that the rule provides sufficient salt to restore electrolytes to normal if the body handles it normally. The second point is that the best response to the salt administered, which is a prompt return of the plasma chlorides and carbon dioxide combining power to normal and an appreciable excretion of salt in the urine showing that the balance is a positive one, occurs in patients who have not been ill for long and are in at least a fair general condition, but have suffered a recent or acute loss of electrolyte containing fluid. Such patients are mainly those with the acute causes of intestinal obstruction. The third point concerns patients who fail to have their plasma chlorides return to normal with the salt administration. These patients have a more chronic illness and the saline solution is utilized in an abnormal manner which is often quite obvious, such as edema formation in dependent parts of the body, or ascites. These patients usually have one or more of the previously mentioned causes for abnormal water and salt retention, that is, general malnutrition, low plasma proteins, sepsis, hemorrhage, profuse serous drainage, or severe hepatic or renal disease. Carcinoma of the gastrointestinal tract is a common lesion in this group, as is also severe sepsis. When given the amount of saline solution calculated as necessary from the clinical rule, the plasma chlorides do not reach normal, but an abnormal distribution of the water and salt occurs. If these patients improve clinically, their fluid and salt are readjusted and the plasma electrolytes approach normal. Experience has shown us that giving more salt than that calculated from the clinical rule is absolutely useless in increasing plasma chlorides, and also that it only aggravates the abnormal distribution of fluids. Years ago it was recognized that plasma chloride levels in patients with pneumonia often remained well below normal despite adequate intakes of sodium chloride, and that improvement occurred several days after the crisis (43). In his investigations of burned patients, Davidson often found plasma chlorides decreased in the face of a good ingestion of salt. Nothing is surprising then about the abnormalities of sodium chloride metabolism in the general run of sick surgical patients.

For the occasional case encountered among surgical patients in which the sodium loss is appreciably greater than the chloride loss special consideration is needed. Two recent examples requiring parenteral fluids were, first, in a patient with marked drainage from an ileostomy done because of chronic ulcerative colitis, and second, in a patient with prostatic and kidneys damaged to the extent of being unable economically to regulate salt and water output. Both patients had a low plasma chloride and carbon dioxide combining power and were given Lactate-Ringer's solution (22), the amount was calculated from the use of the clinical rule. From plasma chemistry determinations both were found to have made a good adjustment of their electrolyte deficiency.

USE OF COMMON INTRAVENOUS SOLUTIONS

Previous paragraphs have dealt with the water and electrolyte needs of surgical patients and it is proper to emphasize further that the choice of solution to be used depends upon the needs of the individual patient.

Five or 10 per cent dextrose solutions provide carbohydrates for energy requirements, for glycogen formation, and for the oxidation of ketone acids if they are present, and there is left a ready supply of available water. Thus, these solutions are suitable for patients who do not need electrolytes but require carbohydrates and water for vaporization and kidney function. It is our custom to use the 5 per cent solution for most patients, reserving the 10 per cent dextrose for those needing larger amounts of carbohydrates, such as individuals with cachexia, hyperthyroidism, or liver damage. Although excellent in their proper place, dextrose solutions fail to relieve or prevent dehydration in patients having lost or losing important amounts of electrolyte containing fluids. We (2, 6) and others (1) have observed the complete clinical picture of severe electrolyte deficiency, namely, lassitude, weakness, drowsiness, anorexia, nausea, muscle cramps, dehydration, and finally shock, from the error of giving dextrose solution in water when a saline solution was needed. Prompt recovery has followed correction by the suitable fluid. Physiological saline solution or Ringer's solution have the materials for the correction

TABLE VII.—THE CONCENTRATION OF SODIUM CHLORIDE IN VARIOUS FLUIDS

	Variation in sodium chloride concentration gms. per liter	A single sodium chloride concentration gms. per liter	Reference
Vomitus	.1 to 6.3	3-3	(3)
Gastroduodenal drainage (Wangensteen suction)	9 to 7.0	5.7	()
Hepatic bile	3.5 to 6.4	5.3	()
Intestinal fistula drainage	3.1 to 6.6 4.7 to 7.9 5 to 8.8	5	(5) (10)
Diarrheal stools	3.7 to 5.3	4.3	()
Physiological saline solution		8.5	U.S.P.
Ringer's solution		9	U.S.N.C. Hosp.
Ringer's solution		7	Abbott Lab.

TABLE VIII.—CALCULATIONS OF SODIUM CHLORIDE REQUIREMENTS FROM THE CLINICAL RULE

Weight kg.	Initial plasma chloride level mgm. per cent.	Calculation
60	460	.0 by 5 by 60 = 30 gm.
60	4	3 by 5 by 60 = 45 gm.
50	500	6 by 5 by 50 = 5 gm.
70	360	by 5 by 70 = 35 gm.
45	440	.2 by 5 by 45 = 17 gm.

After each new milligram that the plasma chloride level needs to be raised to reach the normal (460 milligrams per cent), the patient should be given .05 gram of salt per kilogram of body weight.

maintain normal plasma electrolyte concentrations with the volume-for volume replacement have been due to failures to know the actual volume losses or to give the proper volume replacement.

The second group of patients, those with depleted body water and electrolytes as a result of electrolyte fluid loss previous to admission, usually need a substantial amount of Ringer's solution to restore their water and electrolyte composition to normal. To do this in a quantitative fashion a clinical rule was developed (3, 6) which states that *for each 100 milligrams that the plasma chloride level needs to be raised to reach the normal (360 milligrams per cent) the patient should be given 0.5 gram salt per kilogram of body weight.*

This use of the plasma chloride level as a guide for both chloride and sodium replacement has been a satisfactory procedure in dealing with the electrolyte fluid losses of general surgical patients because such losses are mainly from the upper half of the gastro-intestinal tract and consequently the chloride loss is usually greater than and only occasionally equalled by the sodium loss. As mentioned previously the kidneys with a good supply of water for their function are able to excrete the excess of the less needed ion and to conserve the one mainly required. Examples of the use of the clinical rule in calculating the amount of sodium chloride needed in hypothetical cases are given in Table VIII. The essential data are the patient's weight, which can be approximated if it is not known, and the plasma chloride level. For those determining whole blood chloride instead of plasma chloride the clinical rôle is slightly different (2).

Further experience with the clinical rule has brought out 3 important considerations (4)

fluid losses averages about 5 grams per liter. It is apparent from Table VII that if parenteral therapy is needed and one replaces the fluid loss with an equal volume of Ringer's solution that an adequate replacement of the water and the predominant electrolyte loss will be made (13, 32). This volume-for volume replacement is the fundamental procedure carried out in this group (3, 6). A secondary idea being incorporated. The first of these is that on the day a gastroduodenal suction is started 1,000 cubic centimeters of Ringer's solution is given during the first 24 hours in order to lessen an initial depletion of electrolytes during this period. This liter of Ringer's solution is not counted in the volume for volume replacement, and for the second 24 hours the amount of Ringer's solution given equals the amount of gastroduodenal drainage for the first day. This volume for volume replacement then continues with the addition of the second idea, which is that a minimum of 500 cubic centimeters of Ringer's solution is given daily even if the drainage for the preceding day is less than that amount. This comparatively simple procedure maintains a very satisfactory electrolyte balance in patients losing appreciable amounts of electrolyte containing fluids while under observation. It is working well in the hands of the staff members on the surgical service and requires no special supervision. Blood chemistry studies are done at irregular intervals on such patients, the staff has learned that with the proper carrying out of the procedure the electrolyte chemistry is almost invariably normal. Failures to

TABLE IX.—A CALCULATION OF THE FLUID NEEDED TO CORRECT THE WATER AND ELECTROLYTE BALANCE OF A DEHYDRATED PATIENT

5 per cent dextrose in distilled water	3,500 c. cm. for	a. cm.
Water of vaporization		2,000
Water of urine		1,500
Ringer's solution from clinical rule for		
Correction of dehydration		5,000
Total		8,500

of dehydration and can restore both the fluid and the electrolytes needed. Because there seems to be less abnormal retention of water when Ringer's solution is given to seriously ill patients than when physiological saline solution is given, and because Ringer's solution contains small amounts of potassium and calcium besides sodium and chloride ions (7-15) we believe it is preferable for the correction of dehydration and electrolyte loss.

In order to summarize the use of dextrose and saline solutions Table IX presents a calculation of the fluid needed to correct the water and electrolyte balance of a hypothetical case of dehydration. The patient has been septic and sick for several days and has been vomiting. Laboratory studies show plasma chlorides of 410 milligrams per 100 cubic centimeters plasma carbon dioxide combining power 47 volumes per cent, non-protein nitrogen 40 milligrams per 100 cubic centimeters. The patient's weight is about 60 kilograms. The calculation of the amount of Ringer's solution needed to correct the dehydration was made from the clinical rule "for each 100 milligrams that the plasma chloride level needs to be raised to reach the normal or 560 milligrams per cent, the patient should be given 0.5 gram of salt per kilogram of body weight." The figures for the increase of from 410 to 560 milligrams are 1.5 by 0.5 by $60 = 45$ grams of sodium chloride (Table VIII). The Ringer's solution used at the University Hospital contains approximately 9 grams of sodium chloride per liter so 5 liters are needed in this case for correction of the dehydration. These 5 liters are approximately 8 per cent of the patient's weight of 60 kilograms. This fits in well with our finding from a study of dehydration in humans (9) that the signs of dehydra-

tion appear when a patient has lost an amount of body fluid equal to about 6 per cent of his body weight. Before the use of the clinical rule, this 6 per cent figure was used in calculating the amount of saline solution needed for the hydropenia of a dehydrated patient (31) and it worked very well. Occasionally a dehydrated patient is seen who has not been vomiting appreciably nor been losing gastro-intestinal fluids by other channels, but simply has taken nothing by mouth because of nausea and anorexia and has lost body water by the continuous vaporization of water from the skin and lungs and the urine output. The plasma chlorides and the carbon dioxide combining power are found to be close to normal. Such patients need water mainly for a correction of their dehydration, and a calculation of the amount of dextrose solution in water that should be given for this purpose on the basis of 6 per cent of their body weight has worked well. Most dehydrated patients, however, have had appreciable losses of gastro-intestinal fluid and need saline solution for their hydropenia. At the University Hospital hypertonic salt solutions, 2 to 5 per cent, are not used for correction of electrolyte and water deficiency because the electrolyte loss has always occurred in hypotonic or isotonic solution, and to return the electrolytes enough water must also be added to the body fluids to make the result isotonic. Also many dehydrated patients have hemoconcentration (9) as shown by increased hemoglobin, increased hematocrit, and increased blood specific gravity determinations. To add a 5 per cent sodium chloride solution to this already concentrated state is not reasonable.

Returning now to Table IX, after the calculation for Ringer's solution for dehydration, water for vaporization and for urine also has to be considered, hence 3,500 cubic centimeters of 5 per cent dextrose in water is added for this purpose. The total of 8,500 cubic centimeters is a large volume, but experience has shown that such amounts are commonly needed (9) for the first administration to the severely dehydrated patient. Considering this volume, the rate of administration is important. There is no reason for and there may be particular reasons against giving this

volume in the first 24 hours. In old patients and those with cardiac deficiency the need for such caution is quite apparent. The patient will show signs of improvement with the first 2 or 3 liters and it would be much better to administer the 5 liters of Ringer's solution over 2 days, giving 3,500 cubic centimeters of 5 per cent dextrose in distilled water plus 2,500 cubic centimeters of Ringer's solution during the first 24 hours and the same volume of each solution the next 24 hours. This provides time and plenty of easily available water for the correction of internal fluid and electrolyte adjustment. The rate of administration would be approximately 200 cubic centimeters per hour, which is desirable when large volumes of fluid are given. It should be thoroughly understood that once the dehydration is corrected by a calculated fluid need as shown in Table IX, no patient needs a continuation of anything like such large volumes unless he continues to have an abnormal loss of large volumes of electrolyte containing fluids. Once the dehydration is corrected, the subsequent fluid needs are water for vaporization and urine as discussed under water balance in disease, and Ringer's solution for abnormal gastro-intestinal fluid losses on the plan of volume-for-volume replacement.

As just mentioned, the rate of intravenous fluid administration is important, and to meet all considerations 3 procedures are followed at the University Hospital. When moderate volumes of fluid have to be given, 3,500 cubic centimeters or less, the rate is from 300 to 500 cubic centimeters per hour, which is approximately 5 to 8 cubic centimeters per minute. When over 3,500 cubic centimeters are needed, the administration is placed on a 24 hour basis and the rate is reduced to approximately 200 cubic centimeters per hour. When 10 per cent dextrose is given, the rate is set at 150 to 200 cubic centimeters per hour, since Winslow demonstrated in a group of surgical patients that with slow administration close to 95 per cent of the dextrose is retained and the glycosuria is minimum. When the saphenous vein on the leg or a forearm vein away from the antecubital space is used and when the needle and a small portion of the tubing is strapped firmly in place, the patient is allowed a fair

degree of motion. It is not pain at the site of the intravenous administration that is unbearable, but inability to change position and move about in bed that makes this therapy so tiresome.

The intravenous drip method has proved to be very satisfactory at the University Hospital. Continuous supervision by a nurse remaining at the bedside while intravenous fluids are being given is not required, and no attempt is made to keep the solutions at a constant temperature while in the intravenous apparatus, they are, however, warm when removed from the storage space in the warming closet.

CONCLUSION

Many problems of fluid and electrolyte balance remain to be solved. We have endeavored to present the fundamental aspects of the therapy as used in our surgical wards. We must emphasize that the best way to maintain this balance is to give food and drink by mouth. If this is not possible and parenteral therapy becomes necessary, a knowledge of the fundamentals enables one to maintain or restore the water and electrolyte balance by supplying with practical accuracy the needs of each individual patient. Parenteral therapy tides over an emergency, the sooner the patient is restored to food and drink by mouth the greater his chance of recovery.

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CONSERVATIVE SURGERY IN THE TREATMENT OF BONE TUMORS

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CONSERVATIVE surgery in the treatment of bone tumors implies the employment of an operative procedure which permits of the conservation of an involved extremity or of the continuity or contour of an involved bone. In the case of benign tumors it finds general application, but in the management of malignancies of bone it has a much more limited field of usefulness.

The type of conservative operation suitable for benign lesions varies a good deal with the different classes of tumors. The commonest benign bone tumor is the cartilaginous exostosis or osteoma which arises in the shafts of bones preformed in cartilage. When, because of size, deformity, or pressure effects, removal seems indicated, its base should be severed with a chisel making sure that every portion capped by or containing cartilage is removed. It is very rare that such a neglected tumor situated in a toe or finger becomes so large that it calls for complete excision of the bone or amputation.

Fibrous osteomas which arise from the bones of the face and skull present a somewhat different problem. In some cases they spring from the surface of the bone producing external circumscribed swellings or at most involve only a relatively small amount of the interior, and may be completely excised in a manner similar to cartilaginous exostoses. In other cases they arise centrally and produce more or less expansion of a segment of the bone, in which event complete excision may mean interruption of continuity of bone and marked deformity. In order to avoid these undesirable results such osteomas occurring in the bones of the face and forehead may be treated by the conservative procedure of incomplete removal. The tumor is exposed through an inconspicuous

or the least conspicuous incision, and chiseled away until the normal configuration of the bone is restored. There should be still further removal of as much of the internal portion as is compatible with preservation of continuity and contour. After healing of the soft parts is complete, the remaining portion is treated with roentgenotherapy which usually restrains further growth either to a marked degree or completely. Such tumors usually grow slowly any way. In case there is later enlargement a second operation for restoration of normal contour may be indicated. This treatment is particularly appropriate for fibrous osteomas of the jaws and the peri-orbital frontal regions. It was used with satisfactory results in 5 of the 13 cases of fibrous osteomas of the jaws reported by Phemister and Grimson. The tumors are still under control 4 to 10 years after operation.

Chondromas occur almost entirely in bones preformed in cartilage and, in contrast to cartilaginous exostoses, are nearly always situated within the shafts but produce more or less surface enlargement. The phalanges of the fingers are the usual sites of the lesion. In the great majority of instances they respond to treatment by excision of a window, thorough curettage, cauterization with phenol or other caustic solution, and tight closure of the soft parts. Postoperative irradiation in case of doubt as to complete removal lessens the likelihood of recurrence. Excision of part or all of the bone with replacement by a bone transplant is rarely indicated.

The correct management of benign giant cell tumor is still the subject of debate. In our previously reported experience (11), good results have been obtained in the following way: operative removal of tumor by the application of a tourniquet, excision of a window of cortex, thorough curettage, cauterization with phenol or other caustic solution, filling the cavity with saline and tight suture of soft parts before

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release of the constrictor and application of a cast. Operation is followed by 2,000 to 3,000 r's. More radical procedures are rarely employed. In case of very extensive bone destruction bone transplants may be inserted into the cavity to assist in restoration of the shaft but routine transplantation of bone into the remaining cavity is unnecessary. Complete excision of the involved segment with replacement by a bone transplant, which was formerly used to some extent, is at present still less often indicated. This procedure was used 26 years ago for a tumor of the lower end of the radius and 20 years ago for a tumor of the upper end of the humerus. In each case there is still freedom from recurrence but the functional result from stiffness of the neighboring joint is much poorer than would have followed the more conservative procedure which is now being employed. Excision without replacement by a bone graft is indicated in case the involved bone may be dispensed with as a rib or upper portion of the fibula. Amputation is indicated only in case of complications such as infection following operation with a chronic sinus and failure of healing or malignant degeneration. On the other hand there are many who advocate curettage as Meyerding, Campbell and Coley and Hignbotham, or curettage and bone grafting as advocated by Camp and Clavelin and Sarroste without subsequent employment of roentgenotherapy because of the conviction either that it is unnecessary or that it actually increases the risk of further growth of the tumor.

Hemangioma of bone as a rule, need not be operated upon *per se* as it usually is effectively controlled by roentgenotherapy as shown by the report of Bucy and Capp. When the tumor is situated in a region where the involved segment of bone may be excised without impairment of function, it may be treated in that way as was my case of tumor of the clavicle reported by Bucy and Capp.

BONE SARCOMA

The proper treatment of bone sarcomas of the limbs without demonstrable metastases in the great majority of cases is amputation, since before the diagnosis is established the disease has advanced to a point which makes local

excision unfeasible. This is because of direct extension of the tumor into muscles or veins or about the main blood vessels of the limb. Such extension is likely to occur earlier in tumors beginning peripherally than in those beginning centrally in the bone.

That the general surgical profession has shown little tendency to local excision of sarcoma of the extremity bones is shown by the statistics of the Registry of Bone Sarcoma of the American College of Surgeons as of March 1938. However the Registry records in this respect are somewhat incomplete and indicate a smaller incidence of usage of transplantation than is actually the case. Of the 701 cases of osteogenic sarcoma followed for 5 years or longer 93 were alive and free from recurrence. In 7 cases the tumor was in a trunk bone and was treated by excision and roentgenotherapy. In the 86 cases in which the tumor was in an extremity bone the treatment was by amputation in 82 cases, by resection and roentgenotherapy in 3 cases, and by resection and bone transplantation in only 1 case. Of 155 cases of Ewing's sarcoma followed for 5 years or more there were 15 five year survivals 9 of whom were treated in part by amputation and 5 by resection and roentgenotherapy but in no case was bone grafting recorded.

Eiselsberg and Klapp reported the first case of successful repair of the defect after resection of bone sarcoma by bone transplantation and there have been numerous reports of isolated cases since. In general, the results have been either inconclusive due to the shortness of time since operation or discouraging due to recurrences and complications. The first important series of cases, 6 in number so treated with encouraging results was reported by Lexer. The following cases were free from recurrence with defects restored: 1 of the ulna after 19 years, 1 of the lower end of femur after 7 years, 1 of the humerus after 3 years. One case had a recurrence which necessitated amputation after 3¼ years.

Roscher reported 6 cases of the upper end of the humerus but there was local recurrence with early death in 5 and death from metastasis after 13 years in one.

Albee reported 13 cases, 4 of which from the descriptions bore resemblance to benign gli-



Fig 1a



Fig 1b

Fig 1 Central osteogenic sarcoma of upper 10 centimeters of the humerus a, Before operation, b, excised specimen

Fig 2 Result in case shown in Figure 1, 3 years and 5 months after excision and bone transplantation



Fig 2

cell tumors There were 6 patients with sarcomas of the lower femur, 5 of whom were well with grafts united 6 months to 2½ years after operation The other had local infection and recurrence and an amputation was performed Two patients with sarcoma of the tibia and one patient with sarcoma of the humerus died early of metastases

My own experience with resection of the involved segment and replacement by bone transplantation consists of 7 cases, 5 of which have been reported previously (11) The results in those cases brought up to date are as follows One patient with sarcoma of the mandible in whom one-half of the bone was resected and 1½ years later replaced by a transplant was well 7 years later and then was lost track of One patient with sarcoma of the humerus and 1 of the ulna had local recurrence and metastases

and died 2 to 3 years later One patient with markedly ossifying osteogenic sarcoma of the humerus is now free from metastases 3 years and 5 months after operation (Registry of Bone Sarcoma Case No 2046)

The patient, a male aged 28 years, had had slight pain and swelling at the right shoulder for 4 months A roentgenogram (Fig 1) revealed a diffuse increase in density of the upper 3 inches of humerus and an oval shadow with slight increase in density along its lateral surface Under the diagnosis of osteogenic sarcoma, the upper 4½ inches of humerus, the deltoid muscle, the muscular attachments to the upper end of humerus, and the capsule of the shoulder joint were excised The defect was replaced by a broad graft from tibia and the shoulder joint arthrodesed Gross and microscopic examination confirmed the diagnosis of an ossifying sarcoma A body and arm cast was worn for 4 months During the next 8 months the graft was fractured three times by accidents Despite bone transplantations, one fracture

release of the constrictor and application of a cast. Operation is followed by 2,000 to 3,000 r's. More radical procedures are rarely employed. In case of very extensive bone destruction, bone transplants may be inserted into the cavity to assist in restoration of the shaft but routine transplantation of bone into the remaining cavity is unnecessary. Complete excision of the involved segment with replacement by a bone transplant which was formerly used to some extent is at present still less often indicated. This procedure was used 26 years ago for a tumor of the lower end of the radius and 20 years ago for a tumor of the upper end of the humerus. In each case there is still freedom from recurrence but the functional result from stiffness of the neighboring joint is much poorer than would have followed the more conservative procedure which is now being employed. Excision without replacement by a bone graft is indicated in case the involved bone may be dispensed with as a rib or upper portion of the fibula. Amputation is indicated only in case of complications such as infection following operation with a chronic sinus and failure of healing or malignant degeneration. On the other hand there are many who advocate curettage as Meyerding, Campbell, and Coley and Higinbotham or curettage and bone grafting as advocated by Camp and Clavelin and Sarroste without subsequent employment of roentgenotherapy because of the conviction either that it is unnecessary or that it actually increases the risk of further growth of the tumor.

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Fig 5

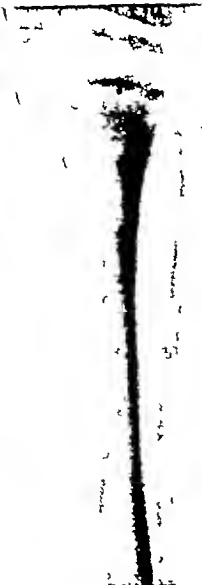


Fig 6



Fig 8a



Fig 8b



Fig 8c

Fig 5 Case 1 Chondrosarcoma of upper end of tibia

Fig 6 Case 1 Showing further growth of tumor 5 months after regional excision

Fig 8 Case 1 a, Shows transplant 1 week after operation, b and c, roentgenographic appearances 13 months after operation

was sectioned. The bone was divided with a wire saw 4 inches below the knee and the upper fragment was lifted forward. The remaining muscular attachments were then divided wide of the bone and the knee joint capsule and ligaments were cut which permitted removal of the fragment without exposure of the tumor. The tourniquet was removed and the bleeding points were ligated. The anterior tibial artery which had been divided was ligated. A sterile tourniquet was then applied to the left thigh and a 9 inch graft was removed from the crest and anteromesial surface of the tibia. It was cut in 2, 1 piece being 5 and the other 4 inches long. The ends of the longer graft were inserted into the medullary canal of the distal fragment and into a groove cut in the mesial condyle of the femur. The shorter graft was inserted lateral to it and sponge grafts were inserted between the denuded head of fibula and denuded lateral condyle. Soft parts were closed tightly although there was a dead space about the grafts which had to fill with blood. A cast was applied to limb and body. Figure 10 shows the roentgenogram 1 week later. An area of necrosis 1 by 2 inches in extent developed in the lateral flap. This gradually separated and the anterior portion of the underlying grafts became exposed. A low grade infection was finally established in the field and 4 months after operation it was questionable if any portion of the 2 large grafts had survived.

Examination of the specimen showed the densely ossified tumor to bulge only slightly beyond the mesial surface. A microscopic section of the entire

specimen (Fig 11) reveals tumor bone throughout the extent of the sarcoma, and in the region of cortical penetration tumor invasion of 2 small surface veins.



Fig 7 Case 1 Specimens excised a, left, at first operation, b, at second operation



Fig. 3, left. Osteogenic sarcoma in reconstructed ulna.
Fig. 4. Same case as Figure 3, 5 1/2 years after excision and bone transplantation.

has remained ununited but the arm is useful and the patient continues his work as dentist. There are no signs of local recurrence or metastases (Fig. 5).

The prospects of a cure are encouraging and if the patient remains free from signs of recurrence much longer he will be urged to have another bone transplantation for the ununited fracture.

Finally, one case (Registry of Bone Sarcoma No. 288) is free from recurrence 5 years and 7 months after operation.

A female, 18 years of age, had lesion of the lower end of the radius, diagnosed as giant cell tumor and treated elsewhere by curettage and radium implantation. Infection and radium burn developed and the patient lost the lower portion of the radius and much of the surrounding soft tissues. The wound healed in about 3 years with the hand markedly angulated and crippled. Five years later plastic operation was done by me on the lower end of the ulna and the position of the hand corrected. Six years later the patient returned with swelling in the lower end of the ulna and biopsy revealed tumor containing scattered giant cells in round and spindle celled field with numerous mitotic figures and some tumor ossification. Malignant degeneration of giant cell tumor was diagnosed. Under tourniquet the lower end of ulna was excised and replaced by tibial transplant. The graft was successful (Fig. 4) and there had been no recurrence 5 years and 7 months later.

There was a difference of opinion as to the diagnosis among the members of the Committee of the Registry who examined the excised specimen. Some considered the tumor malignant while others regarded it as still a benign giant cell tumor. I believe it was an osteogenic sarcoma.

Since the previous report 2 additional cases of sarcoma of the upper end of the tibia have been operated upon by resection and bone transplantation.

CASE 1. Female, aged 3 years, first noticed slight swelling of the upper end of the shaft of right tibia anteromedially 18 months before admission. Five months previously roentgenograms revealed an oval, flecky shadow of calcium density along the medial surface of the upper 4 inches of the tibial shaft (Fig. 5). Under the diagnosis of benign cartilaginous tumor the lesion was then excised locally. There was, however, further growth of the tumor and on admission there was a firm mass over the posterior and lateral sides of the upper 1/2 inches of the shaft. A roentgenogram revealed shadow of calcium density most marked along the lateral surface in the upper region of the swelling (Fig. 6). Examination on dissection was otherwise negative including roentgenograms of the chest. Under the diagnosis of chondrosarcoma and with tourniquet hemostasis, the upper 5 inches of the tibia were excised, the neck of the fibula was broken accidentally during the maneuver. Under a tourniquet a whole thickness graft of crest and lateral cortex of the left tibia was removed and inserted into the defect of the fibula as connected with external condyle. Figure 7 shows the specimens excised at the operation and microscopic examination revealed calcifying and ossifying chondrosarcoma of low grade malignancy. Bony union followed, and walking with brace was resumed after 7 months. There was no sign roentgenologically or otherwise of recurrence metastasis 7 months following operation. Figure 8 shows roentgenographic appearances week and 3 months after operation.

CASE 2. A male, aged 5 years, had noted small, oval, slightly painful swelling of the anteromedial surface of the upper end of the shaft of the right tibia for 6 months before admission. Physical examination confirmed the presence of the swelling but otherwise revealed negative findings. Roentgenograms revealed an oval area of increased density in the medial aspect of the upper 1/2 inches of the tibial diaphysis extending slightly beyond the surface (Fig. 9). The lungs were roentgenologically normal. Diagnosis osteogenic sarcoma. At operation (without biopsy under tourniquet the upper third of the tibia was exposed through an anteromedial incision, leaving an ellipse of overlying skin and subcutaneous fat attached to it. Muscles were reflected posteromedially and laterally and the upper tibiofibular joint



Fig 12

Fig 12 Case 3 Chondrosarcoma of humerus



Fig 13

Fig 13 Case 3 Photomicrograph showing hyaline and calcified chondrosarcoma



Fig 14

Fig 14 Case 3 Roentgenogram showing condition 5 years and 1 month after local excision and roentgenotherapy

12) Sarcoma, benign giant cell tumor, and cyst were considered. At operation the tumor was cut into and a soft, bluish-gray tissue removed. Frozen section revealed a chondrosarcoma, which diagnosis was later confirmed by fixed tissue sections (Fig 13). The lesion was then thoroughly curetted and chiseled away and the soft parts closed tightly. Within 60 days following operation the patient received 7,500 r's. The pain disappeared from the shoulder and 5 years and 5 months afterward he was free from clinical and roentgenographic evidences of local recurrence or metastases. Figure 14 shows the roentgenographic evidence of healing of the bone defect. Moderate muscle atrophy and limitation of motion of the right shoulder are present.

CASE 4 Female, aged 23 years. For 2 years the patient had had pains in the region of the right hip which had gradually progressed, causing a limp and interference with function. Six months before admission a tumor of the ilium was diagnosed elsewhere and 5,250 r's were given, 2,550 anteriorly and 2,700 posteriorly to the region. Some improvement in local symptoms followed the treatment but the pain had been worse for the past 2 months following a fall.

Examination was essentially negative aside from a decided limp in the right lower limb, limitation of motion of the right hip, and a slight swelling deep seated and low over the back of the right ilium. A roentgenogram (Fig 15) revealed extensive destruction of bone of the top of the acetabulum and of the adjacent ilium for a distance of 2 to 3 inches. At operation (Dr Harkins) the posterior surface of the lower ilium was exposed by splitting the lower part

of the gluteus maximus muscle and reflecting the underlying rotator muscles. The cortex was missing and a soft tumor with a fibrous covering hinged from the surface of the ilium. It was removed by chiseling, dissection, and thorough curettage. The tumor was grayish brown in color and there was relatively little bleeding. The acetabular roof was completely eroded for an area 1 centimeter in diameter. Microscopic examination of the tissue (Fig 16) showed extensive necrosis scattered throughout a round and spindle celled tumor undoubtedly the effect of the x-ray. But in the viable regions the tissue was composed of spindle cells presenting the appearance of a fibrosarcoma. There was primary wound healing. Fourteen hundred r's were then given. The patient walked without crutches 2 months following operation, the lump rapidly disappeared, and she is now free of all symptoms and signs of tumor 3 years after operation (Fig 17).

While it is difficult to evaluate the rôles of roentgenotherapy and operation in the healing, it seems rational to assume that the removal of the tissue, which was partly of viable spindle-cell structure, was a factor of some importance in controlling the process.

CASE 5 Female, aged 42 years. The patient had had pain in the region of the left hip for 8 months which gradually increased and was aggravated by exertion, causing her to limp. There were no general symptoms nor weight loss. Physical examination was



Fig. 9a



Fig. 9b



Fig. 10

Fig. 9. Case 2. Central ossifying sarcoma of upper end of tibia.

Fig. 10. Case 2. Bone graft in position one week after operation.

Despite the flap necrosis and loss of bone graft it should be possible later on to restore

the continuity of the tibia with ankylosis at the knee by shifting the divided fibula into the defect. The case is reported at this early date to illustrate the dangers that may be encountered in a case which at the beginning because of its confinement to the bone appeared most suitable for this type of operation.

Local excision of the sarcoma without interruption of continuity of the segment of bone is a procedure to be avoided except under very pressing circumstances as inability to obtain consent or certainty of marked loss of function after a more extensive operation. However it is worth knowing that if such a procedure is combined with roentgenotherapy, there may be repair of bone and freedom from recurrence of the tumor for worth while periods of time as illustrated by the following cases.

CASE 3. Male aged 3 years. The patient complained of gradually increasing pain in the right shoulder for 7 months with only slight impairment of function. Physical examination as negative aside from slight limitation of motion in the right shoulder. Roentgenograms of the chest showed normal appearing lung fields. A roentgenogram of the right shoulder revealed large area of destruction in the mesial portion of the met. physis and adjacent head of the humerus. With rather heavy outlines (Fig.



Fig. 11. Case 3. Microscopic section showing distribution of ossified tumor within the cancellous region and beneath the slightly elevated periosteum.



Fig 12

Fig 12 Case 3 Chondrosarcoma of humerus



Fig 13

Fig 13 Case 3 Photomicrograph showing hyaline and calcified chondrosarcoma



Fig 14

Fig 14 Case 3 Roentgenogram showing condition 5 years and 1 month after local excision and roentgenotherapy

12) Sarcoma, benign giant cell tumor, and cyst were considered. At operation the tumor was cut into and a soft, bluish gray tissue removed. Frozen section revealed a chondrosarcoma, which diagnosis was later confirmed by fixed tissue sections (Fig 13). The lesion was then thoroughly curetted and chiseled away and the soft parts closed tightly. Within 60 days following operation the patient received 7,500 r's. The pain disappeared from the shoulder and 5 years and 5 months afterward he was free from clinical and roentgenographic evidences of local recurrence or metastases. Figure 14 shows the roentgenographic evidence of healing of the bone defect. Moderate muscle atrophy and limitation of motion of the right shoulder are present.

CASE 4 Female, aged 23 years. For 2 years the patient had had pains in the region of the right hip which had gradually progressed, causing a limp and interference with function. Six months before admission a tumor of the ilium was diagnosed elsewhere and 5,250 r's were given, 2,550 anteriorly and 2,700 posteriorly to the region. Some improvement in local symptoms followed the treatment but the pain had been worse for the past 3 months following a fall.

Examination was essentially negative aside from a decided limp in the right lower limb, limitation of motion of the right hip, and a slight swelling deep seated and low over the back of the right ilium. A roentgenogram (Fig 15) revealed extensive destruction of bone of the top of the acetabulum and of the adjacent ilium for a distance of 3 to 4 inches. At operation (Dr. Harkins) the posterior surface of the lower ilium was exposed by splitting the lower part

of the gluteus maximus muscle and reflecting the underlying rotator muscles. The cortex was missing and a soft tumor with a fibrous covering bulged from the surface of the ilium. It was removed by chiseling, dissection, and thorough curettage. The tumor was grayish brown in color and there was relatively little bleeding. The acetabular roof was completely eroded for an area 1 centimeter in diameter. Microscopic examination of the tissue (Fig 16) showed extensive necrosis scattered throughout a round and spindle celled tumor undoubtedly the effect of the x-ray. But in the viable regions the tissue was composed of spindle cells presenting the appearance of a fibrosarcoma. There was primary wound healing. Fourteen hundred r's were then given. The patient walked without crutches 2 months following operation, the limp rapidly disappeared, and she is now free of all symptoms and signs of tumor 3 years after operation (Fig 17).

While it is difficult to evaluate the rôles of roentgenotherapy and operation in the healing, it seems rational to assume that the removal of the tissue which was partly of viable spindle-cell structure, was a factor of some importance in controlling the process.

CASE 5 Female, aged 42 years. The patient had had pain in the region of the left hip for 8 months which gradually increased and was aggravated by exertion, causing her to limp. There were no general symptoms nor weight loss. Physical examination was



Fig. 5



Fig. 7

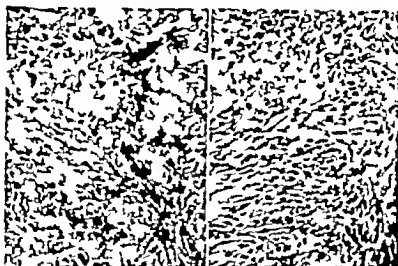


Fig. 6

Fig. 5 Case 4. Roentgenogram of non-calcifying sarcoma of ilium.

Fig. 6 Case 4. Photomicrographs: a, left, partly degenerated and calcified area (effect of roentgenotherapy); b, viable area.

Fig. 7 Case 4. Roentgenogram showing condition 3 years and 6 months after operation.

essentially negative aside from the left hip region. There was slight tenderness on palpation just above the greater trochanter but no mass was felt. A roentgenogram (Fig. 8) revealed an oval area of reduced density with more or less worm eaten outlines in the left ilium just above the acetabulum. Roentgenograms of the chest showed no signs of metastases.

A diagnosis of sarcoma of the ilium was made. At operation the gluteal muscles were reflected from the side of the ilium exposing a tumor which was covered

in some regions by a thin layer of bone and in others only by thickened periosteum. The covering was cut and a moderately vascular grayish soft tumor was dissected and thoroughly curetted. Eighteen radon seeds were then implanted about the walls and the wound was tightly closed. The pathological report was that of the Ewing type of round cell sarcoma. The wound healed by primary union. Roentgenotherapy was begun 2 weeks later and during the following 6 months she received 4,400 r's.



Fig 18



Fig 19a



Fig 19b

Fig 18 Case 5 Ewing sarcoma of ilium

Fig 19 Case 5 a, Two weeks after the excision and

radon seed implantation, b, the result 1 year later after roentgenotherapy



Fig 20 Case 5 Sarcoma of clavicle with pathological fracture

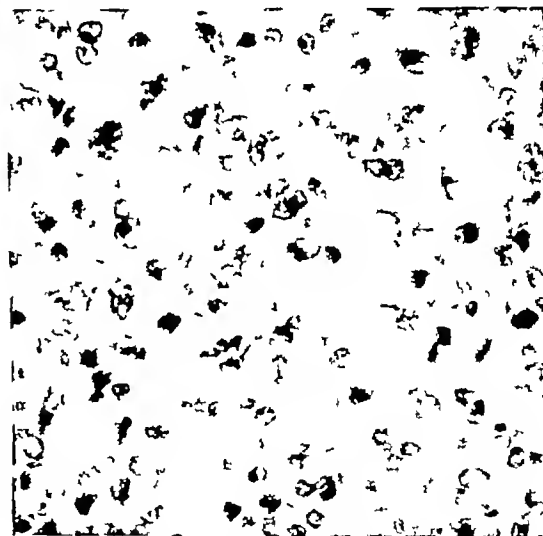


Fig 21 Case 5 Photomicrograph of biopsy specimen



Fig 22 Case 5 Four and one-half months later Repair following roentgenotherapy

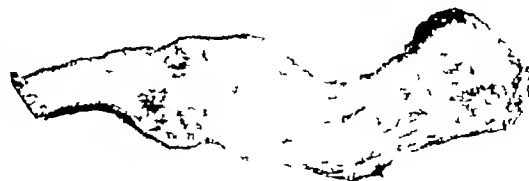


Fig 23 Case 5 Section of excised clavicle showing fibrous union of fracture and disappearance of soft tumor

Pain gradually disappeared and function returned to normal during the period. The roentgenograms (Fig. 9) taken weeks and again 1 year after operation show the defect and the repair which followed. Chest symptoms developed about 1 year after operation and pulmonary metastases, demonstrated roentgenologically, resulted in fatal termination months later without recurrence of symptoms or signs at the seat of the primary tumor.

A bone sarcoma of the radiosensitive type which is so extensive that an attempt at local removal seems inadvisable may first be treated by roentgenotherapy and then excised in case it becomes sufficiently reduced in size. Excision may be resorted to even when the sarcoma appears to have been eradicated by roentgenotherapy, since in such cases growth may again set in after long periods have elapsed. Thus a sarcoma of the upper third of the femur repaired strikingly under roentgenotherapy but recurred 4 years later. Bone transplantation for repair of the defect after excision may or may not be indicated according to the region involved. In the following successful case involving the outer one third of the clavicle the functional result was satisfactory without it.

CASE 6. A male aged 33 years, sustained a pathological fracture of the outer third of the clavicle. Examination revealed a soft tumor of the outer third of the clavicle with ecchymosis. A roentgenogram (Fig. 20) showed irregular bone destruction and fracture through the region. A biopsy (Fig. 2) disclosed round cell sarcoma (recently pronounced reticulum cell sarcoma by some committee members of the Registry of Bone Sarcoma). Because of the size of the tumor and of the hematoma in and about it excision did not seem possible. The only feasible operation would have been intrathoracoscopic amputation. Intensive roentgenotherapy as then administered and the mass disappeared. Four and one-half months after the biopsy the clavicle was excised including the thorax adjacent to the region of the tumor. A study of the specimen showed the absence of tumor and fibrous union of the fracture (Fig. 3). Microscopic sections showed no definitely recognizable tumor cells in either the bone or the surrounding soft parts. There was primary wound healing and in the course of a few months the function of the extremity returned to normal. The patient

has remained well and 14 years later there is no sign of local recurrence of the tumor or of metastases.

CONCLUSIONS

These experiences warrant the conclusion that in carefully selected cases resection of bone sarcoma and repair of the defect with a bone graft is a justifiable procedure which may save an extremity and carries only slightly more risk to life than does amputation. Also in cases in which for any reason amputation or resection of the involved segment cannot be carried out a combination of local excision and roentgenotherapy offers a somewhat better prognosis than roentgenotherapy alone.

By the employment of these procedures a limited percentage of extremities could be saved that are now being sacrificed by amputation.

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DECOMPRESSION IN THE TREATMENT OF INTESTINAL OBSTRUCTION

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DECOMPRESSION of the intestine is the oldest and most obvious form of treatment for intestinal obstruction. I speak of decompression in its broadest sense without respect to the method by which it is accomplished. The oldest method of decompression of the obstructed bowel is that of blind puncture of distended loops of the bowel by use of a needle or trocar. This method was occasionally successful in relieving distention, but it rarely relieved the patient of the obstruction. Carried out blindly, it offered little to the patient except the dangers of peritonitis and the method never became popular.

A more controlled method of decompression of the distended bowel, enterostomy, has been practiced with more success for over a hundred years. In cases of simple acute obstruction enterostomy was sufficient to relieve the obstruction, but in the majority of cases left much to be desired, since it did not attack the cause of the obstruction, and when used as a preliminary operation enterostomy did not always restore the patient to better health preparatory to an attack on the obstruction itself. The appraisal of the use of enterostomy in the treatment of intestinal obstruction given by Treves, in 1884, seems worthy of quotation:

"I cannot avoid the conclusion that a primary enterotomy is not to be advised. The operation is at the best but a palliative measure, it is not founded upon sound surgical principles, it is a procedure that is carried out more or less independently of diagnosis, it is an operation done in the dark, and it leaves the cause of the disorder untouched. It is true that it does not show so high a mortality as does laparotomy, but the disadvantages of the procedure are many. In the first place, as already stated, it leaves the real malady itself untouched. To this statement there are a few exceptions. There

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are some forms of obstruction that are in great measure produced and maintained by distention of the bowel, among such are certain forms of volvulus (which are rare), some cases of occlusion by kinking, by adhesions, and by changes in the visceral peritoneum or mesentery. Such cases may be cured by enterotomy, and a closure of the artificial anus may follow the operation. Some cases also of faecal accumulation and of obstruction by a foreign substance may be so far relieved by enterotomy that the artificial anus may close in time, or be closed by some plastic measure. But how stands the matter in other cases? The obstruction remains. If it be an example of acute strangulation, or of volvulus, or of intussusception, then the gut may become in time gangrenous, and the patient die practically of the direct effects of an unrelieved, or imperfectly relieved, obstruction of the bowel. If the obstruction be due to cancer, the cancer is left untouched, and the operation merely gives some temporary relief. Suppose, however, that after the enterotomy no further changes of a destructive or malignant character take place about the seat of obstruction, what is the condition of the patient? There is a permanent faecal fistula in the groin. This leads into the small intestine, and may be the cause of wasting, and, if higher up in the bowel than usual, of death from marasmus. There may be, moreover, a considerable portion of intestine between the artificial anus and the obstruction, and the accumulation of faecal matter in this part of the bowel may lead to the greatest distress. The ileum has actually been opened to relieve a case, not diagnosed at the time, of simple stricture in the upper part of the rectum, and in other examples of enterotomy the seat of the obstruction has been in the descending colon and the sigmoid flexure."

Despite these deprecating remarks, enterostomy has advantages in selected cases of intestinal obstruction. The procedure is simple and may be applied to those patients who could not stand the exploration necessary to find and correct the cause of the obstruction. It permits decompression of the distended bowel and allows the patient to eat and absorb nourishment at least down to the point of the opening in the bowel. Careful attention to the wound and to an adequate supply of fluids parenterally may be expected to minimize the dangers of wasting.

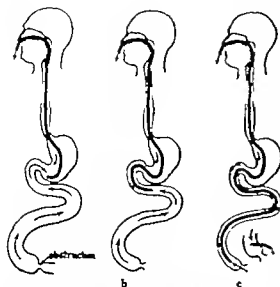


Fig. 1. Illustration of differences in direction of flow in intubation at various levels and by enterostomy. a, Gastric drainage; b, duodenal drainage; c, small intestinal drainage.

While these methods owe their effectiveness to decompression of the bowel the modern connotation of the term decompression relates to the use of tubes introduced into the intestinal tract through natural orifices.

This method of accomplishing relief of distention likewise is not new. Westermann, in 1910 reported the use of continuous gastric drainage in cases of ileus associated with peritonitis and stated that the method was first used by Tarnier in 1888. However as an adjunct in the treatment of intestinal obstruction it has only recently been widely used. Ward in 1925, advocated the use of gastric intubation with suction in the treatment of intestinal obstruction and Wangenstein and his associates have greatly extended the use of the method by their many studies and have emphasized the need for passing the tube into the duodenum. Shortly after the report on this subject by Wangenstein and Faine we became interested in the use of duodenal siphonage, and after some experience recognized the method as a decided advance in the treatment of intestinal obstruction. There were, however certain cases in which no marked relief or at best only temporary relief was attained. It was my good fortune to be

acquainted with the work of Dr. William Oser Abbott and Dr. T. Grier Miller at the University of Pennsylvania when they were developing their tube for intubation of the small intestine. The Miller Abbott tube offered the possibility of extending the efficiency of suction drainage, by affording drainage at bottom rather than at top of distended column of fluid and gas. With Dr. Abbott the method was tried and found to be practical (1, 8).

Actually the underlying principle of the various methods of decompression by means of intubation is the same. Differences lie only in the level from which the material is aspirated. With the intestinal tube at the level of the obstruction adequate aspiration is similar to an enterostomy performed just above the level of the obstruction (Fig. 1) and has this additional advantage—the level from which material is aspirated may be varied at will.

The method for accomplishing intestinal intubation has been described in other publications (1, 8, 9, 12, 13). It consists of the use of a tube approximately 20 feet in length at the lower end of which an inflatable balloon is attached. With the tube in the duodenum the balloon is inflated and peristalsis propels the tube downward until stopped by obstruction to its passage. We prefer the use of a large tube for aspiration with a smaller tube for inflation of the balloon rather than the original double lumen tube they have been found more efficacious in supplying drainage and they are much cheaper (Fig. 2).

Obviously with decompression possible when the tip of the tube is in the stomach or duodenum many of our patients have not required that the tube be passed further. However with the advantages offered by intestinal intubation in the determination of the type, extent, and level of the obstructing lesion we have in many cases allowed the tube to pass further even when not necessary for relief of distention. One other advantage afforded is that with the tube passed well down in the small intestine the patient may be fed a diet low in fiber content, and absorption of food, fluid, and salt occurs. In obstruction low in small intestine it is frequently possible to maintain nutrition, fluid, and salt balance without resort to parenteral fluids.

The disadvantages as well as the advantages of intestinal intubation in the treatment of intestinal obstruction are well kept in mind. Of the disadvantages the most obvious is the possibility of failure to recognize interference with the mesenteric blood supply. That the recognition of strangulation is possible on the basis of the history, physical examination, and reaction of the patient is evidenced by the fact that of the last 22 such cases, accurate diagnosis was made in all but one and in this case the history, onset, and development of symptoms before entering the hospital were inaccurately given. Even were it not possible to recognize strangulated obstruction, on the basis of the relatively low incidence of this condition, it would not cause a serious increase in the mortality rate.

The difficulty of introducing the tube into the duodenum in certain cases is a handicap in this method. During the past 3 years we have had 6 patients in whom we were unable to pass the tube into the small intestine. During this time we have successfully passed the tube into the small intestine approximately 500 times. There is no doubt that intubation of the small intestine is hard work and requires constant care if it is to be effective.

The tube occasionally causes irritation to the nose and throat and is uncomfortable, but this can usually be controlled by lubrication and by instillation of a solution of 1 per cent metycaine or nupercaine into the nostril. We had one patient who developed otitis media during treatment, and another in which there was a rupture of esophageal varices presumably from trauma by the tube.

The advantages might be listed as follows: (1) It offers a means for relieving the patient's distention without operation, thus relieving him of his symptoms. (2) This procedure makes it possible to delay surgery safely until the patient is in better general condition with a normal fluid and chemical balance. (3) Operation then becomes a procedure of election rather than of emergency. The technical difficulties attendant upon operating amid distended loops is removed. (4) It is frequently possible to localize the obstruction accurately before operation by means of small amounts of barium given through the tube.

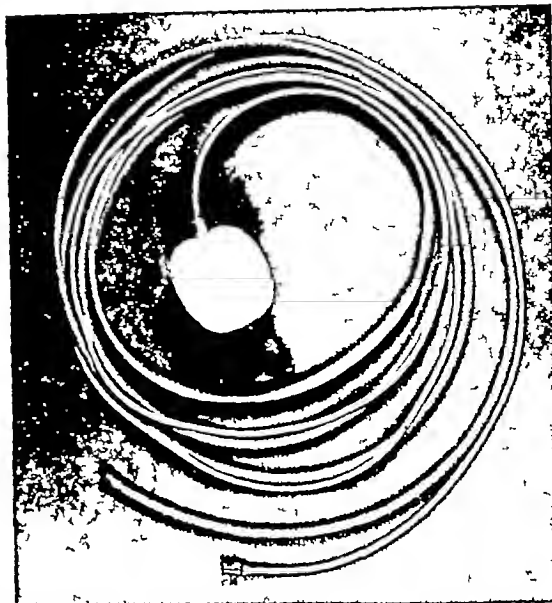


Fig. 2 Intestinal tube which we have found most practical

(10) The barium can be washed out at will following roentgenographic studies, since the tube tip lies at the point where the barium puddles. (5) Once the tube passes well into the small bowel much of the absorptive area of the intestine lies above its tip. It is then possible to maintain the patient's nutrition by oral feeding of a high caloric and low fiber diet. This is not possible when gastric or duodenal aspiration is in progress. (6) In adynamic ileus there seems to be always enough muscular power left in the intestinal wall to pass the tube down once the overdistention is relieved. No other method we have tried has approached the uniformly successful results we have had in treating adynamic ileus by intubation.

In addition to intestinal obstruction we have found the use of intestinal intubation of assistance in other conditions. Incisional hernias so large as to appear inoperable may be successfully repaired after the passage of the tube well down in the small bowel. After intubation the volume of the intra-abdominal content is smaller. This permits not only of adequate reposition of intestine without undue tension from pressure within the abdomen, but assures the ability to control postopera-

TABLE I.—MORTALITY FROM SIMPLE
INTESTINAL OBSTRUCTION

	No.	Per cent
Lived	80	9
Died of obstruction	6	9.5
Died of other causes, distention present	3	4.8
Died of other causes, no distention	3	4.8
Total mortality—all cases		9

This represents 41 patients treated by intubation but does not include cases of strangulated obstruction, adynamic ileus, or patients operated upon without intubation.

tive distention. Intubation to produce what is in effect a low ileostomy preceding operations on the large bowel, has been reported to me by Dr I S Ravdin. We have used the method in controlling loss of fluid with the associated digestion of superficial tissues due to leak from an enterostomy opening. We have had but one of these cases, and this patient's difficulty might well have been obviated by use of the tube primarily instead of the performance of the enterostomy.

In our experience the use of intestinal intubation has had a decided effect on the reduction of mortality from intestinal obstruction. During the past 3 years we have had 64 cases of simple intestinal obstruction with a mortality of 9.5 per cent. In the group of cases where the obstruction was not the chief cause of death the mortality was 9.5 per cent. Including all cases, whether or not the obstruction played any rôle in the demise, the mortality was 19.2 per cent (Tables I and II). These figures do not include cases of intestinal obstruction unsuitable for treatment by in-

tubation such as strangulated obstruction and uncomplicated cases of intestinal obstruction which were operated upon immediately because of lack of reaction or excessive distention, nor do they include cases of adynamic ileus which were treated by intubation. Of the latter group a survey has been made which does not materially change the mortality in the entire series treated by decompression, since there were 73 of these patients of which 17 died. The mortality in this group was 23.6 per cent the deaths being due, with but 3 exceptions, to intraperitoneal infections.

The philosophy behind the use of decompression is based on sound principles. It is worthy of note that there have been many concepts developed with regard to the causative factors for the trend of events in fatal cases of intestinal obstruction and from these concepts have come worthwhile contributions to therapy. It is unfortunate that the rôle of distention in initiating other more serious considerations, should have received so little attention. In addition to the work of W angenstein in stressing the importance of decompression the experimental data of Herrin and Meek, Taylor and associates, and Burget and associates have done much to consolidate the concept that with the control of distention, other disastrous phases of intestinal obstruction need not follow.

These workers proved that it is possible to produce the symptoms of intestinal obstruction by distending the intestine even when no

TABLE II.—PATIENTS WHO DIED AS A RESULT OF OBSTRUCTION

Patient and age	Cause of death	Decompression	Remarks
L V 6	Richter's hernia, perforation of duodenum, peritonitis	Unsuccessful	Patient had diaphragmatic hernia. Unstrapped Richter's hernia. Tube never left stomach.
M T 69	Perforation of duodenum, peritonitis	Successful Unsuccessful	Patient unstrapped, obstruction at terminal ileum completely decompressed. Patient awake after 46 days intubation, but operation deferred to allow pain in stomach. After 4 days tube re-obstructed and intestine perforated before tube could be passed. I and adherent band bound across terminal ileum with peritonitis.
N G	Intestinal obstruction	Successful (late)	Refused all treatment. Home on release. Returned 7 days later. Failed to die and refused intubation. Intubated successfully. Ions removed.
H 80	Intestinal obstruction	Successful	Refused intubation. Adhesions band released in operation. In past 4 days her death. Cause given occurred and relieved by intubation. Sudden return of abdomen 12 hrs before death. A very thorough complete decompression.
H G 66	Intestinal obstruction, ileus	Successful	Chronic intestinal obstruction, atropine retention, as result of long standing distention, decompressed, chills normal, but operation unsuccessful.
M B 5	Perforation of intestine and peritonitis, thyroid crisis	Unsuccessful	Previously suffering from hyperthyroidism, thyroid crisis precipitated by obstruction. Tube on duodenum, patient pulled out in distention and could not be reintubated. Autopsy revealed static ileus of intestine due to protracted distention with perforation and peritonitis.

TABLE III—PATIENTS WHO DIED FROM CAUSES OTHER THAN OBSTRUCTION—DISTENTION A PART IN OUTCOME

Patient and age	Cause of death	Decompression	Remarks
J O 52	Nephritis diabetes mellitus, uremia	Partially successful	Patient had old fistula following enterostomy Tube thought not to offer advantage, inserted but removed by irrational patient. Blood sugar 390 urea, 115, CO ₂ 33 Chlorides always within normal limits
A. O 77	Pyelonephritis, retro-peritoneal abscess	Successful	Ten days distention and obstipation Gastric suction 3 days before seen by us Patient died of infection, but long continued distention probably played a part in her death
R. J 26	Pyelonephritis uremia	Successful	Patient's obstruction overcome at this and two previous admissions Previous admission for pyelonephritis Abdomen flat one week before death Chlorides within normal limits, Blood urea 118

TABLE IV—PATIENTS WHO DIED FROM CAUSES OTHER THAN OBSTRUCTION—DISTENTION NO PART IN OUTCOME

Patient and age	Cause of death	Decompression	Remarks
W P., 13	Tuberculous peritonitis	Successful	Tuberculous peritonitis
V J, 37	Subhepatic abscess	Successful	Pelvic abscess, with wide-spread peritonitis
A. G 67	Myocardial failure and pulmonary edema	Successful	Gall-stone obstruction uremic and disoriented on admission Prepared for operation for 3 weeks gall-stone removed Patient died of myocardial failure 9 days later Autopsy revealed no cause for death in abdomen

obstruction is present, and that even in the case of a closed loop obstruction, deleterious symptoms could be prevented by decompression of the loop

It is worthwhile to point out that decompression of the bowel in simple intestinal obstruction is but one phase in the treatment of this condition. The necessity of supplying fluid and salt as emphasized by Andries and McLean, Hartwell and Hoguet, and later by Haden and Orr, McIver, Collier and others is important, no matter what other therapeutic measures are carried out. In obstruction due to a definite organic lesion, operation is still an imperative necessity, but with advances in the control of the distention by intestinal intubation and better localization of the lesion the operation is made easier for the surgeon and less formidable for the patient.

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THE MANAGEMENT OF CHRONIC PELVIC INFECTIONS

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ALTHOUGH pelvic infections still occupy an extremely important position among gynecological problems, tubal disease is a less frequent indication for surgery nowadays. The chief factors responsible for this decrease are less gonorrhea in women and an almost universal adoption of non-operative management for acute salpingitis. With the decreased incidence of gonorrheal salpingitis there has been an increase in pelvic endometriosis to us, this appears to be further confirmation of Sampson's "retrograde menstruation and implantation of endometrium theory. In other words, the more tubes that are patent, the greater the likelihood for endometriosis to develop.

We usually think of acute inflammation of the internal genitalia as the result of an ascending gonorrheal infection, as an aftermath of an infected abortion, or as a feature of puerperal sepsis. However it is my impression that a considerable number of the acute pelvic problems encountered today are not gonorrheal, postabortive nor puerperal they are not tuberculous and they do not follow acute appendicitis. These upper genital infections are becoming more and more difficult to decipher. No doubt some result from a spread of an inflammation in contiguous structures a few are pelvic localizations from a distant focus of infection. Some result from an endocervicitis complicated by a cervical stricture others are an aftermath either of too ambitious endocervical cauterization or of intra-uterine radium therapy especially when the uterus is retroflexed. A few may be dependent on the present vogue in feminine hygiene, namely the wearing of vaginal tampons rather than the conventional vulval pads. Some believe that a trichomonas infection is responsible for an occasional acute inflammation in the upper genital zone.

Acute salpingitis should not be a surgical problem because the disease is usually self limited. The period of morbidity is shorter with conservative management furthermore, acutely inflamed structures are more likely to rehabilitate themselves if they are not mutilated by operative trauma.

Women with acute tubal disease may require surgical interference when physical signs and clinical symptoms suggest an associated acute appendicitis, which is extremely rare and also if there is a localization of pus in the cul-de-sac which can be drained readily via a posterior colpotomy. I am impressed, however that there is a tendency to institute cul-de-sac drainage too frequently nowadays. Attempts to drain inaccessible adnexal masses by this route should be discouraged. Posterior colpotomy with drainage should be reserved for a bulging pelvic abscess, when there is persistent fever a high leucocyte count, and clinical observation has demonstrated that the patient's general condition is not improving. If one is conservative, he will find that many pelvic masses resolve promptly and spontaneously without resorting to cul-de-sac drainage.

All of us, occasionally have been chagrined to operate on an acute tubal infection, when we suspected either an acute appendix, a tubal pregnancy or an ovarian cyst with a twisted pedicle. These questions arise. Shall the tubes be removed or is it advisable to close the abdomen immediately? Is an appendectomy permissible? Is drainage necessary? Each case must be managed on its own merits. If one is dealing with the first attack of an acute salpingitis, he should be more conservative than in a patient who has had previous tubal infections. If the tubal involvement is a simple catarrhal inflammation and the fimbriae are free, one should not remove the tubes. If the tubes are thickened, filled with pus, and the fimbriae are sealed, they may be removed one can scarcely imagine that sealed tubes will undergo spontaneous resolution and

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again become patent The appendix may be removed, routinely Few, if any of these cases, require drainage

Gynecologists are inclined to use drains too frequently They are necessary when the integrity of the rectum, sigmoid, ureter, or bladder is in question They are also indicated if one drains an abscess, but the routine use of drains after a total hysterectomy probably increases postoperative morbidity In pelvic surgery drains through the posterior vaginal fornix are preferable to drains through the abdominal wall Gravity favors the escape of fluids through a vaginal drainage tract whereas the abdominal wall is often weakened by the use of a drain The incidence of ventral hernias, after gynecological operations, seems to vary directly with the presence of infection in the abdominal wall and with the use of drainage tubes

We are delighted with recent additions to the older methods of conservative treatment for acute tubal disease Sulfanilamide has found one of its chief fields of usefulness in the Frauenklinik, i e , in the treatment of acute gonorrhea and in the management of post-abortive and puerperal infections We are also enthusiastic about pelvic heat therapy as an aid in hastening resolution of subacutely inflamed pelvic structures, my personal experience is limited to the Elliott apparatus and to diathermy

Relatively few women with acute gonorrheal salpingitis, postabortive infections, and puerperal sepsis ultimately require surgery for the correction of the residues of the acute inflammation This does not imply that most of the acutely inflamed structures eventually undergo complete resolution and that the pelvic organs return to a normal state, but it does mean that only a few of the end-result lesions are responsible for symptoms

Granting that acute pelvic infections should be treated conservatively by expectant measures, and recognizing that approximately 20 per cent eventually require surgical interference, how is one to determine when the process has reached a stage of chronicity from which no further improvement can be expected by palliative measures? The time element is an important factor One should wait at least a

year, or preferably a year and a half, after an acute attack of gonorrheal salpingitis has subsided before operating, the only exception being the individual who repeatedly is reinfectd Under such circumstances the operation should be performed soon after an acute attack has subsided, i e , before she has an opportunity to become infected again After a cellulitis type of infection one should postpone operation indefinitely The resolution of such a process is slower and the dangers of operating are greater, because streptococci tend to linger for months, even years, in the pelvic tissues The presence of fever is a contra-indication to surgical interference, unless one is operating to drain an abscess or to remove it By the same token a high leucocyte count, with a relative preponderance of polymorphonuclear neutrophils, is a contra-indication to surgery We have not been impressed by the sedimentation rate as a helpful measure in distinguishing between active and chronic infections, although a rapid sedimentation rate is more likely to occur with an active infection Exquisite pelvic tenderness, induration of tissues, and the presence of cellulitis usually denote a relatively active infection

Most women, with pelvic residues which require surgery, present the following complaints pelvic pain, uterine bleeding, or sterility Rarely are pelvic residues a focus of infection We have seen chronic ovarian abscesses, Skene's duct abscesses, and pyometra due to cervical obstructions that were foci of infection, however, these sites exhaust the practical possibilities in the female genital tract for such foci

Occasionally, operation becomes necessary because an ovarian abscess or a tubo-ovarian abscess fails to resolve after months of careful palliative management Under such conditions removal of the abscess is the preferred procedure Removal is sometimes impossible, usually it is a dangerous undertaking, frequently loops of small bowel, the rectum, a ureter, or the bladder are adherent to it, and these viscera may be injured as one attempts to mobilize the abscess However, if the sigmoid or rectum is injured at such an operation it tends to close spontaneously, the same

pertains to a vesical fistula produced in this manner. It follows, therefore, that drains should be used, almost routinely after the removal of an ovarian or tubo-ovarian abscess.

Rarely are we confronted by a chronic cul-de-sac sinus or a persistent lower abdominal sinus. It has been our experience that such sinuses become chronic either because there is a foreign body in the sinus tract, because the primary infection was tuberculous, or because there is an ovarian abscess which drains continuously and thus prevents spontaneous healing. Under such conditions the entire sinus tract should be removed, including the focus responsible for its persistence.

Genital tuberculosis is rare. It is an extremely difficult pre-operative diagnosis and we have not been impressed that these women are usually amenorrhoeic most of them consult us because of uterine bleeding. We also recognize the difficulties in diagnosing tuberculous salpingitis at the operating table. However the following gross features merit comment. Tuberculous adhesions are dense and unyielding. The tubes, although inflamed and thickened, tend to be pale rather than reddened in 50 per cent the fimbriae are said to be free. On palpation, the tubes may be nodular or beaded and occasionally one may see or feel tubercles on the serosal surfaces. Genital tuberculosis is a secondary lesion and, as a rule, results from the scavenger action of the fallopian tubes in picking up caseous fragments or tubercle bacilli that have been spilled into the abdominal cavity from intestinal or mesenteric foci. Tuberculosis extends downward through the genital tract along mucosal surfaces. Consequently the incidence of tuberculosis in a given genital site varies inversely with the distance of the organ under consideration from the fimbriated ends of the tubes. In other words, tuberculosis of the tubes is most common tuberculosis of the ovaries and endometrium is next in frequency while involvement of the cervix, vagina, and vulva is extremely rare. Radical operative procedures are indicated usually it is unwise to preserve an ovary in the face of a tuberculous infection. Afterward these women should be managed by an internist a sojourn in a sanitarium is often beneficial.

It is customary when elective gynecological laparotomies are performed, to explore the upper abdomen before investigating the pelvis. We have been particularly interested in a syndrome, first described in 1930 by Dr. Arthur H. Curtis. It consists of string-like adhesions between the capsule of the liver and the diaphragm although adhesions are not present in the general abdominal cavity almost invariably however there are pelvic residues of a previous gonorrhoeal infection. Curtis found, in reviewing histories of patients with these 'violin-string' adhesions over the liver that some had experienced right-sided 'pleurisy' pains during an attack of acute salpingitis. He also has had the opportunity to observe women with right-sided 'pleurisy' like pain during an acute attack of gonorrhoeal salpingitis and years later when the healed residues of the genital infection were operated upon has found adhesions over the liver.

Today most gynecologists recognize the relationship of violin-string adhesions over the liver to genital gonorrhea. However it is not known why the inflammatory exudate tends to localize over the liver. It might be suggested that the adhesions result from a hepatitis, however this seems unlikely since women do not exhibit signs and symptoms suggesting parenchymatous liver involvement during the acute illness. Others believe that gonococci are transported to the diaphragm and then to the liver via retroperitoneal lymphatics and veins. However for gonococci to be disseminated via the blood vessels and lymph channels seems unlikely and would be at variance with their usual mode of spread through the genital tract. It seems more probable that the adhesions over the liver are mute evidence that a generalized peritonitis complicated the acute salpingitis. Generalized peritonitis was suggested as the probable explanation for these adhesions in Curtis' original paper. The manner in which gonococci spread from the lower genital tract to the peritoneum is along contiguous surfaces, namely from endocervix to endometrium, endosalpinx, and pelvic peritoneum. Consequently in more severe or more virulent infections it would not be surprising if the organisms spread throughout the

entire abdominal cavity and produced an inflammation of all serosal surfaces

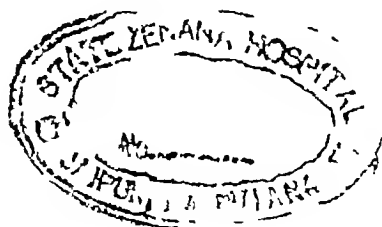
Granting that the gonococcus causes an acute generalized peritonitis more frequently than has previously been appreciated, why should the resulting adhesions be restricted to the pelvis and the surface of the liver? By the very character of the adhesions it must be assumed that the gonococcus usually is responsible for only slight serosal damage. Dr Barry Anson, of our anatomy department, has suggested that modest acute inflammation of the peritoneum is likely to result in subsequent adhesions only over immobile structures. Consequently, after a severe gonorrheal infection of the upper genital zone, one might expect to find adhesions over the liver which is immobile and in the pelvis, there might also be a few adhesions around the spleen which has more mobility than the liver and around the appendix and cecum, which are relatively immobile.

I am not enthusiastic about surgical attempts to open occluded fallopian tubes for the relief of sterility. If the tubes are sealed at the fimbriated ends, one can expect that about 30 per cent will remain patent after salpingostomy. If there is obstruction in the isthmic or interstitial portions, plastic operations are almost certain to fail.

If one removes both fallopian tubes, the corpus of the uterus also should be removed. Some contend that the uterus has a function of internal secretion, I doubt if this has been proved. If the tubes are absent, the patient is sterile and the uterus has been deprived of its function, furthermore, we have found that many women eventually suffer from uterine

bleeding after a bilateral salpingectomy. Consequently, we now advocate hysterectomy whenever both tubes are removed, in the long run, it is the more conservative procedure.

If one ovary is diseased and the other one is normal, the diseased ovary should be removed *in toto*. I am opposed to the common practice of incising, aspirating, and excising cysts from ovaries, because an ovary does not react kindly to surgical trauma, it tends to become scarred, cystic, and adherent and often is the site of continuous pelvic pain. By the same token, if all of one ovary must be removed and most of the opposite ovary must be resected, then we believe that all of both ovaries should be removed. Young women, for whom only a small portion of one ovary can be saved, tend to suffer for years after such an operation, not only do they suffer from pelvic pain at the site of the ovarian stump but also are constantly harassed by mild but "never-ending" menopausal symptoms. Under these circumstances, all ovarian tissue should be removed, even though the patients are plunged precipitously into the menopause. They seem to recover more promptly from this type of surgical menopause and they are free from pain. We have learned that bilateral oophorectomy for this group of young women is the less radical procedure. Endocrine therapy has proved most efficacious in relieving menopausal symptoms. I am convinced that women will be essentially free from hot flashes and other disagreeable manifestations of the change of life if given an adequate amount of estrogenic hormone. However, one must administer relatively large doses to many patients if they are to obtain the desired results.



THE 1939 CLINICAL CONGRESS

THE METAMORPHOSIS OF THE SURGEON

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THE opportunity of making what may be termed a commencement address is fully appreciated and highly valued. Representing a profession which is not notable for its oratorical gifts and which is usually singularly inarticulate one approaches such a presentation with considerable temerity. There is comfort, however, in knowing that, contrary to the custom in scientific circles, no immediate public opportunity will be allowed for discussion.

It would seem to be a fitting time to appraise certain trends in surgery. Since the beginning of this century the place of surgery in the whole field of medicine has undergone a profound alteration so that the former man of handicraft has become a diagnostician, a most essential therapist, and an investigator of some merit. During this same period medicine as a whole has developed to the extent that it must be considered not as one profession but as a number of professions the intimate relationship of which must be fostered and maintained for not only are they dependent on each other but they have a common goal. It behooves us to recognize the weaknesses inherent in our method of advance and to avoid pitfalls insofar as our foresight permits.

The American College of Surgeons has made its concern certain standards of attainment for the surgeon and also has worked consistently for the improvement of the environment in which his work is done. Membership in this organization, while a recognition of your capacity is at the same time an enrollment in a group which has certain aims which you can support and further and for which all of us must plan. Its potentiality depends not upon

the establishment of monuments but rather upon the kinetic drive of all interested in the future of our profession. Education, training, and facilities are among our principal concerns. In its officers, board of regents, directors, library and even its multiplicity of committees, this College has counterparts in our many universities and other schools of education. As in them our concern is with the search for truth and the pursuit of knowledge but in addition, we have the specific aim of turning them to the advantage of the surgical patient. This is our reason for existing. From time to time a consideration of the changes occurring in medicine will affect our course of procedure and our methods of operation.

Our concern must be not only with sound practice which has grown from knowledge gained in the past, but with plans to further that progress. A clear view of our destination prevents the charm of attractive trails and sidepaths from distracting us on our journey. The beginner in the field of medicine is impressed with the vast bulk of accumulated medical knowledge and is appalled at the prospect of acquiring any considerable part of it. The numerous subjects and courses and the mystic maze of library stacks contribute to a feeling that here is represented a vast fund of medical wisdom, fixed and substantial. His is the task of engulfing and digesting a required amount, so the poor student protrudes a tentative pseudopodium toward it. Like the amoeba, the more stimulation he receives the more he will surround but the quality and rate of his digestion vary considerably. Later in his studies and in practice he realizes that this inherited trust fund of medical bequests from the past is not complete. Often it does not contain the final word and he notes that when any subject is pursued the limits of our knowledge in it are soon reached. There lies opportunity

From the Department of Surgery, University of California Medical School.

Address of the retiring president, presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 4-10, 1939.

for individual and independent inquiry, for exploring unknown territory, and for advancing knowledge. In the accomplishment of this it has been said that fortune favors the prepared mind. Foresight and proper groundwork are essential. As our individual lives are determined by our adaptability to our environment, so in the life of surgery we must consider those factors which bear upon its relationship to the entire field of science as well as to our social organization. The increase of surgical therapy has brought increased responsibility to the surgeon. When we realize that two-thirds of the patients in our general hospitals are surgical patients, our immediate responsibility is obvious, but quite beyond this is the added obligation of carrying forward the progress in a correspondingly large part of the entire field of medicine and of using our opportunity to improve the science and the art of surgery.

You have, in the judgment of your fellows, attained certain standards of knowledge and proficiency based upon the facts acquired by our scientific forebears and the skills of your teachers. It is wholesome for each of us to realize, however, that inheritors deserve little credit and that our followers will appraise us only as creators. Admiration and inspiration come from a knowledge of and familiarity with the great contributors to science in the past. At present, the abilities of any capable surgeon to diagnose and to treat are so far in advance of those attained by the very greatest surgeon of a few score years ago, that we may be tempted to consider the past as a convenient backdrop for the stage upon which we display our accomplishments of today, rather than to derive sufficient stimulation to urge us on to contribute whatever we may according to our capacities.

Medicine progresses through the basic sciences, physics, mathematics, chemistry, biology, and numerous others. It may be likened to a growing stream. The first springs feeding it arose in the far distant past and to their flow additions have come from these many scientific sources. In the last 400 years, comprising the development of modern scientific medicine, the stream has become a great river. As students, we acquire some knowledge of its origin,

some familiarity with its substance, and on it we embark as practitioners with equal opportunity. All are carried along to some extent, but we quickly become scattered, and real progress depends upon aptitude and perseverance. In no field of human activity do the voyages of exploration carry more allure. For each there is the opportunity to direct his own course, contribute to his own progress and, in the spirit of adventure, search new horizons.

This onrushing torrent threatens to overwhelm us at times as we appreciate our inability to familiarize ourselves with its vast extent. Modern scientific medicine is but four centuries old, less than six lifetimes of three score years and ten, and modern surgery is scarcely 60 years of age. The surgeon of the short robe has gone far. Sixty years ago the practice of medicine was in the hands of the general practitioner. Surgery was limited in amount and represented but a small part in the treatment of the sick. Though specialism began in antiquity, surgical specialists, for the most part, did not exist even as late as the beginning of this century. Up to this time it was within the capacity of a well-trained internist to familiarize himself with all the instruments of diagnosis and to acquire the skill needed to use the armamentarium, the cystoscope, ophthalmoscope, proctoscope, esophagoscope, x-ray, and to perform spinal puncture. How impossible it would be in the present day for any one person to familiarize himself with all the available techniques! Since that time, the various diagnostic methods have become so refined and elaborated that today the otologist, the urologist, the radiologist, the ophthalmologist, the thoracic surgeon, the neurological surgeon, or other specialist must be called upon for the complete studies required in the various fields. With these advances the specialists have acquired greater diagnostic ability and can be credited with advancing the knowledge of pathology and physiology as well as operative treatment in their special fields, so that they have made these activities their own. Such developments have rendered the physician of the present day dependent upon the findings of those who have more advanced and specialized knowledge than he possesses, as well as the special technique

General medicine, as contrasted with surgery is occupying a gradually narrowing sphere. Such a trend has its implications for the surgeon or the surgical specialist in that he must assume the broad responsibility for the welfare of his patient rather than for a narrowly viewed surgical condition. Only a few years ago the general practitioner saw the beginning of a disease and perhaps was aided in diagnosis by the internist, while the specialist was consulted, finally only for treatment. At present a specialist is required in diagnosis and many diseases are recognized in their earlier stages. The existence of this development has been reflected in the attitude of the public who in the presence of an abdominal emergency or of disorders in some particular part attempt to seek the appropriate specialist directly. It is fortunate for surgery that the acquisition of technical methods and diagnostic skill has led, in the hands of so many to an interest sufficiently detailed to permit the furtherance of our knowledge in its basic cognate sciences. This knowledge has permitted the operator to metamorphose into the surgeon who considers the operation but one item in the care of his patient and to whom the correct diagnosis, well judged preparation, and interested and intelligent aftercare are as important as the operation itself and are equally his responsibilities. Attributed to the great surgeon Lord Monrohan, is the statement that he liked to consider himself a physician who had sometimes to employ surgery to cure some of his patients.

Much, however may be said of the disadvantages of such a scheme of specialism and it is our concern to meet and correct them. As noted before the increase in medical knowledge is such that medicine can no longer be regarded as a single profession but must be considered as a number of professions developing from a common trunk. In many communities, for example general surgery concerns itself largely with little more than the upper two-thirds of the abdomen and the neck. We must recognize therefore, the growing spheres of activity in all of the surgical specialties and yet remain alive to their coasanguinity. The mutuality of interest of these children of common parentage is evidenced in the Amer-

ican College of Surgeons, and the bonds uniting them should be strengthened. All of them have a common aim—the welfare of the patient but the difficulty of keeping this clearly in mind when specialism has become too narrow is well attested by the numerous pleas of medical educators to treat the patient as a “biologic entity” or a “psychosomatic unit, rather than by isolated organs or parts. It seems obvious that specialism will increase as long as men continue to select and to pursue their special interests, and furthermore that it has become a scientific and practical necessity.

The trend in all of our larger cities is toward greater specialization, and also in many of the cities of secondary size medicine has become narrowly divided. With the increasing number of specialists who are being trained, and for economic reasons as well, it is evident that all of the specialties will be represented soon in still smaller communities. With increasing population and greatly improved methods of transportation only a few communities will be so small and so remote that they must of necessity be served only by general practitioners. The field of the specialist in the future will lie in the areas which have within a radius of 15 or 20 miles, a population of 20,000 or more. It seems entirely possible to me that better service may be rendered under such conditions than can be given by the general practitioners now serving these sections.

Both the strength and certain weaknesses of modern medical education a development of the present century have become apparent. It is not so long since the aspiring medical man attached himself to a practitioner as preceptor and served as office boy, hostler, assistant, and companion while he carried on his medical reading and this period was succeeded by a limited course of lectures and the receipt of a degree. A great advance was made when premedical requirements were extended to include chemistry, physics, biology and languages, and certainly this preparation for medicine has greatly advanced the understanding of the medical student. Combined with a lengthened medical course, including firm grounding in preclinical and clinical subjects and laboratory work this regimen has resulted in the development of better prepared practitioners.

In more recent years, with lengthening postgraduate training, still higher levels of proficiency are being attained. The benefits and advantages of such an educational plan are too apparent to require special comment, but what may be said of any weaknesses which have developed? It has become plain that such a program of preparation for medicine as is required in premedical work is reasonable for the average student. One weakness, however, lies in the concept that preparation and training should be the same for all men, without taking into account their individual strengths, their individual interests, and their individual aptitudes. In our educational scheme, *breadth* of background has been stressed in preparing our men for medicine. As a result, those entering medical training have achieved this, at least to some extent, while only a few have acquired *depth* of knowledge in any one of the subjects covered.

The introduction to the basic sciences contained in a premedical course involves no great familiarity with the subjects, it requires, in fact, the minimum which will permit an understanding of the courses which follow. Men have varying interests and the medical profession attracts men of widely different types of mind. We recognize that progress in medicine is dependent on the increases in knowledge arising in such basic sciences as physics, chemistry, and the biological sciences and the application of such knowledge to medical requirements. Yet we have not encouraged the admission to medical college of those who have depth of knowledge in these sciences and who are familiar with recent progress in them. The mathematician, the well prepared physicist, the able chemist, or the psychologist who is attracted to medicine finds great fields of application for his knowledge, but these opportunities are closed to those of us not so prepared. Can we not offer inducements to attract such men into medicine?

An analogous situation appears in postgraduate training. During the early days of modern surgery, late in the last century, the immediate necessity for the budding surgeon was a knowledge of anatomy, for surgery is applied anatomy. Such knowledge is an essential part of the equipment of the surgeon, for

without this local geography at his fingertips he would be an unwelcome explorer in the human body. During the early period of surgery, then, anatomy was stressed, the entrance into the profession was by the anatomical route. During this time, the details of operative approach and exposure, technical advances, and instruments adapted to the task were the common contributions to surgical progress. As more general agreement developed on the anatomical aspects of these procedures, and with the adoption of accepted methods, attention broadened from the exclusively anatomical viewpoint, and the importance of surgical pathology was recognized, then emphasized, and now has become incorporated as a necessary and most highly valued part of the training of the modern surgeon. This is said with the full knowledge that even now preparation in this subject is too often woefully inadequate, for its importance cannot be overstressed. As additional background for surgery, our best graduate training schools also insist upon a period spent in the experimental laboratory, which ordinarily implies training in some branch of physiology. Not a little of the prominent place that surgery now occupies is due to the recognition of the necessity for and insistence upon such training in this triad of preclinical subjects for men who expect to become surgeons. These fields are receiving attention and opportunity is not lacking for contribution in them.

A point that I wish to make, however, is that our present scheme of premedical and medical education and graduate training tends to be standardized to the point that we cannot always take full advantage of the capacities and special aptitudes of the men entering our profession. I wish to emphasize again that the advance of medicine depends upon the contributions made by the application of fundamental knowledge coming from the basic sciences and that, while our men entering medicine have some breadth of knowledge with a smattering in each of many subjects, only a few enter with a sufficient depth of knowledge in any one of them to utilize their information in the application of the recent advances to medical needs and medical advancement. Although our plan of premedical training has resulted in a vast improvement in the quality

of medical practice I cannot but feel convinced that the progress of medicine as a science in contrast with practice would have been furthered even more had we admitted to our medical schools men who had majored in one of the basic sciences and had acquired depth of knowledge in some one branch, as well as sufficient breadth in several to utilize fully their medical teachings. Our profession will be immeasurably advanced if we can induct into it men with profound knowledge in physics, psychology, chemistry, mathematics, and each of numerous other fundamental sciences. To men in medicine who have a special interest in one of these fields there is great promise in furthering that knowledge for the applications to medicine of recent advances in science lag many years behind, far longer than they need to do if this intimacy of interest can be attained. Many of us can recall occasional instances in which an engineer or chemist became interested in medicine and with his eyes thus opened his energies permitted vast dividends in accomplishment which are impossible to those not so prepared.

Likewise in the field of graduate training in medicine let us not attempt to standardize the preparation of all men and restrict them to certain minimum requirements in any specialty. Anatomy, pathology and physiology are stressed and rightly so but for the student of particular ability and some special interest let us be in a position to encourage what may seem to be an immediate divergence from his ultimate aim for by such means progress will be assured. In the fields of biochemistry and bacteriology how many surgeons can we name who have sufficient basic knowledge of these subjects to prosecute investigations intelligently? Yet the opportunities for the surgeon to apply such detailed knowledge are on every hand.

Not all of us have an absorbing interest in a basic science or a preclinical subject. Most of

us find more appeal in the recognition of disease and our ability to treat it. The able clinical surgeon can by thoroughness and careful study of his cases, contribute largely to surgical progress. His observations and inquiries point the way for experimental and laboratory investigation.

I urge however that there is a smaller number with special talents whom we must endeavor to recognize and encourage. I refer to those who may be induced to enter medicine after having had training in a basic science and also those who in the period of graduate training for surgery may be induced to separate themselves temporarily from clinical work in order to ground themselves deeply in one of the preclinical subjects. We are familiar with the contributions from the anatomist surgeon and the surgical pathologist; physiological contributions of the first order have come from experimental surgeons. Equally great opportunities lie ahead for the well trained surgeon who is also a biochemist, a bacteriologist, or an immunologist. Let us foster where possible the development of such men. Great store may be laid by them and from such sources will surgery be strengthened. Experience has shown that an intimate relationship of the departments representing various sciences mutually strengthens and aids each. It has likewise shown that when these viewpoints are brought together in the mind of a single person the possibilities of the application of such knowledge to medicine and surgery are greatly enhanced and hastened.

The artist may express his thoughts and his emotions through the deftness of his hand; the scientist, by experimental methods, brings forth the children of his brain by his acts; the humanitarian evidences the greatness of his heart. To each of us, as a surgeon, belongs the great privilege of membership in the profession in which, as in no other, are combined all of these qualities of head and heart and hand.

THE 1939 CLINICAL CONGRESS

THOMAS A. SHALLOW, M.D., F.A.C.S., Philadelphia, Pennsylvania

NO other meeting, whether educational, medical, surgical, political, or social, has so filled the Philadelphia Academy of Music as that of the Convocation of the American College of Surgeons on October 16, 1939. Among the initiates were representatives from 42 states, Canada, and other foreign countries. Honorary fellowships were bestowed upon Surgeon General James C. Magee, of the United States Army, Surgeon General Thomas Parran, of the United States Public Health Service, and Dr. Eugene Pólya, titular extraordinary professor of surgery, at Peter Pázmány University, Budapest.

The importance of all the features which make up this Clinical Congress was clearly appreciated, therefore, it was the desire of the Committee on Arrangements in preparing the program to continue the excellent example set forth by previous Congresses. Representatives from all Philadelphia and suburban hospitals were invited to participate and a committee was formed to present all the surgical features which would be of interest. In this way, it is believed, all available material was obtained.

For many years surgical organizations had for their stock-in-trade the ability of their members to operate skillfully and to be dramatic. However, it has been the aim of the American College of Surgeons to put an end to these histrionic demonstrations and in their place dry clinics and panel discussions have been substituted. Judging by the attendance, one can say with certainty that these types of presentation are rapidly gaining favor. In addition, there were afternoon symposia on the subjects of fracture, cancer, urology, diseases of the respiratory tract, obstetrics and gynecology, and graduate training. These discussions attracted large audiences who evidenced great interest in these topics.

Chairman of the Committee on Arrangements

The evening sessions, which embraced a variety of subjects, brought to light numerous advances in the fields of medicine and surgery. The papers covering the work on vitamins, especially on the influence of vitamin K in its relationship to the prothrombin time, were worthwhile contributions. Vitamins, it was demonstrated, reduce mortality and morbidity, placing many jaundiced patients in a relatively safe condition for surgery. Other papers on vitamins indicated that almost 40 per cent of patients who enter the hospital border on scurvy, and this disclosure should open the field for the proper investigation into dietary deficiencies.

It was also proved conclusively at this meeting that surgery is more than a mechanical art and that the mortality and morbidity of surgical patients have also definitely declined. Patients are no longer rushed into hospitals and operated upon immediately. They are properly studied and, within the past few years, properly prepared for surgical measures. The papers on pre-operative preparation of surgical patients were among the most notable features of the meeting.

One of the outstanding contributions was a discussion on the diagnostic value of the peritoneoscope in demonstrating the location of lesions and their operability, the presence of metastases, and even the opportunity to study tissue removed by means of this instrument, which has been a definite safeguard for potential surgical subjects, saving many with incurable conditions from needless operative procedures and permitting them to be treated expectantly.

One of the highlights of the Convocation was the annual oration in surgery delivered by Dr. Evarts Graham,¹ of St. Louis. It is interesting to note that Dr. Graham was one of the recipients of the John Scott Award in 1937 for his notable contribution to a more accurate diagnosis of biliary tract disease. By

¹The address by Dr. Graham will appear in a later issue.

his ingenuity he was able to apply that which was lacking in pure laboratory methods and to demonstrate the hitherto unrecognizable disorders of the liver and gall bladder. In his oration Dr. Graham discussed intrathoracic tumors and clearly pointed out that major surgery of the chest requires more than operative skill and courage. The anatomical and physiological problems which are constantly presenting themselves were ideally portrayed by him and all who heard him profited by his excellent discussion. At the election of officers which took place during the annual meeting on Thursday, October 19, Dr. Graham was chosen president-elect.

The president for the ensuing year is Dr. George P. Muller of Philadelphia. The retiring president, Dr. Howard C. Naffziger of San Francisco, who has played no small part in the advance of neurological surgery, struck a new chord in his address. He stressed the need of depth as well as breadth of knowledge. He urged that scientists in other fields, such as chemistry, physics and mathematics be encouraged to enter the fields of medicine and surgery in order that the depth of their own

scientific knowledge be utilized for the advance of medicine and surgery.

Surgical films were presented each day during the Congress and, as in previous years, this concrete means of presentation proved a great favorite. It was gratifying also to witness the growing interest in the scientific exhibits which deal with subjects related directly to the various activities of the College and coupled with these exhibits were those of a number of national organizations.

Another outstanding feature was the lectern and desk which were on display at the Bellevue Stratford Hotel. These are to be presented to the Royal College of Surgeons of England in appreciation of the gift of the Great Bace which was given to the American College of Surgeons by the Consulting Surgeons of the British armies at the close of the World War.

The Congress was characterized by good fellowship and the interest and co-operation of the various surgical units of the Philadelphia hospitals and hospital managements and the Committee on Arrangements wishes to take this opportunity to thank all who helped to make this meeting such a success.

TWENTY-SECOND ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

MALCOLM T MACEachern, M D , Chicago, Illinois

HOW widespread have been the benefits of Hospital Standardization is particularly perceptible each year during the hospital conference, when from all parts of the United States and Canada hospital executives are assembled to discuss their problems. No matter what these may be, there is evident satisfaction in the feeling that a central authority exists through which the sometimes divergent views may be sufficiently reconciled to make possible the working out of standard procedures which all may advantageously follow. Much of the work of Hospital Standardization has been accomplished through this process of facilitating expression of opinion by the people in the field, who need only guidance and a centralizing force to help them solve their own problems. Through choice, hospitals have elected to follow the Minimum Standard, and through a democratic ideal of encouraging full discussion and hearkening to all ideas expressed, the College has tried to make this hospital activity a genuine service to those directly concerned, namely, the hospital, the doctor, and the patient.

In extending the helpful influence of Hospital Standardization, the College relies to a great degree upon the enthusiasm of its individual Fellows. It is they who are responsible for keeping this force operating with maximum effectiveness. The surgeon can stimulate the hospital or hospitals with which he is connected to exemplify in practice the most up-to-date interpretation of the principles set forth in the Minimum Standard. And he can bring to the attention of the College, from his close contact with the actual needs, his ideas on how the Hospital Standardization program may be made increasingly helpful to hospitals.

There should be a large measure of satisfaction to the Fellows of the College in the

expressed reactions of members of the hospital profession to the service being rendered through the hospital program. Several examples may be taken from the talks at the 1939 conference. The rehabilitation of a large county hospital which was in bad repute, declared a member of its board of trustees, was quickly accomplished "through the joint efforts of representative citizens, the medical profession, local hospital administrators, and the strict but helping hand of the American College of Surgeons." The progress and advancement made by the hospitals in Canada during the past 20 years, said another speaker, "are due, in no small measure, to the result of Hospital Standardization and to the great interest stimulated by, and the supervision given by the College." The superintendent of a small hospital referred to the College as a "beacon light" for that type of institution.

The small hospital undoubtedly represents a field in which the hospital program should be intensified. In the opening address at the conference, President Howard C. Naffziger of the College referred to the need, saying

"In the hospitals recommended for graduate training for surgery we are dealing with the conspicuously bright scholars of the hospital world. There is a great deal of promising material also among those who for one reason or another lag near the foot of the class. Outside influences may be responsible for their relative inability to keep up with today's standards. Public ignorance and indifference are factors to which blame for their plight may often be traced. A program of public education in hospital service will help the small hospital, and to such a program all hospitals, and organizations such as the College which have to do with hospitals, should contribute. For the weaker institutions tend to handicap the strong. Hospitals have come a long way in the twenty-two years since the first Hospital Standardization Conference. They have a long way yet to go before the hospital needs of every type of community are met adequately.

"Since approximately 94 per cent of all hospitals having 100 beds and over are approved, evidently

the deficiencies and inadequacies are to be found mostly in the small hospitals. By helping the small institutions to attain higher standards, as it is constantly doing, the College is making the benefits of Hospital Standardization felt in communities which may be far outside of metropolitan areas. The small hospital, however, must merit approval before it is granted, for no concessions can be made in the fundamental principles of Hospital Standardization.

There can be no doubt that many hospitals in the smaller communities are having a difficult struggle to keep operating, let alone meet high standards of service. Yet there is agitation to build more hospitals, in rural and semi-rural communities, to be supported by taxation. Obviously if the amounts proposed for supplying new facilities could be appropriated instead to rehabilitation, and, if need be to the extension of existing hospitals the net result would be more and better hospital service to raise the health level of the community. To duplicate existing facilities is not to increase hospital service, because a factor of competition would enter which would almost inevitably force the voluntary hospital out of existence in favor of the tax supported institution. The community would then have changed only its type of hospital service not the amount. This condition would not hold everywhere, of course. There undoubtedly are a few instances in which a community should have a new hospital, because in the distribution of hospitals it was for one reason

or another neglected. On the whole, however, a hospital is conveniently accessible to most people. In fact, it seems that but 13 counties in the United States are more than 30 miles distant from a reputable hospital, and that only 5 of these 13 counties have a population of more than 5 people per square mile.

The real problem is to bring these existing hospitals in rural and semi-rural communities up to higher standards, to increase their bed capacity if needed, and to expand their out-patient services. Mainly the approach to a solution of this problem is through educational channels. The people of the entire area which the hospital may be developed to serve should be awakened to the need for supporting it, and apprised of the ultimate economy of conserving the hospital resources they already have. No doubt, aid from tax funds should in many cases be given, because the load of needy patients will be greater than the hospital and its private benefactors can bear. But in so far as practicable the institution should be supported locally because of the many advantages of local control.

Thus while the College and its fellowship are proud of the growing number of approved hospitals—reaching 2,720 in 1939—they are also keenly aware of the many current problems with which hospitals are faced. To help in their solution is a continuing aim of Hospital Standardization.

GRADUATE TRAINING FOR GENERAL SURGERY AND THE SURGICAL SPECIALTIES

DALLAS B. PHEMISTER, M.D., F.A.C.S., Chicago, Illinois

FEW activities in which the American College of Surgeons has become engaged have stirred so much interest as the program of graduate training for surgery. In the evolution and development of this field there has been considerable confusion, little or no correlation, and, in many instances, radical differences of opinion on the subject of how a surgeon is to be trained. The chief direct sufferer during this process of development has been, of course, the aspirant to a surgical career. Indirectly, the whole profession, and frequently the patient and the public, have suffered with him.

Surveys and analyses thereof by the College, under the direction of the Committee on Graduate Training for Surgery, have helped to bring to light the extent of the confusion and to disclose some of the basic causes for disagreement, thus awakening the profession and hospitals to the need for determination of standards. The College, through the formulation of fundamental principles for graduate training in surgery, has been able to provide a general guide at least for the development of acceptable programs of training.

Recognizing the demand for more formal training of the surgeon, the College in 1936 raised the requirements for fellowship. To comply with the resolution adopted May 10, 1936, candidates for fellowship must have spent 2 years or more in surgical training in acceptable hospitals following a year of hospital internship after graduation from medical school. This new requirement affects applicants whose qualifying medical degree has been obtained since January 1, 1938, or, in the case of graduates of medical schools, which withhold the degree until after the fifth year of hospital internship, the effective date is January 1, 1939.

The College was therefore obligated to lend every effort toward encouraging acceptable

Chairman of the Committee on Graduate Training for Surgery

programs of training for its future fellowship. There was available to prospective Fellows, however, no source of complete and accurate information on the opportunities for graduate training in general surgery and the surgical specialties which would meet the new requirements for candidacy. Teachers and preceptors of the medical student or interne could not always offer him proper guidance in planning a satisfactory course of training. Their knowledge was often limited to their own experience and the few training programs with which they had become acquainted by observation or hearsay.

Not the least of the accomplishments of the graduate training work of the College has therefore been the collection of information on a large number of plans, and its dissemination to those whose advice and guidance is sought by the medical student, the interne, and the more recent medical graduates, eager to acquire further education and training in surgery. In the past year or so there have been published in the *Bulletin* of the College, which is distributed to all Fellows, junior candidates, and approved hospitals, detailed descriptions of the plans of 42 institutions for graduate training in general surgery and the surgical specialties. In the aggregate, this constitutes an impressive store of information on the subject. It has already proved to be of the utmost value to present and prospective members of the surgical profession and to hospitals seeking to gain ideas for bettering their present programs or for instituting acceptable plans in cases in which no program had yet been adopted.

To this factual data already published there will be added from time to time descriptions of other plans, and possibly all can be combined eventually in a revised form under one cover to constitute a convenient source of reference covering acceptable programs for graduate training in surgery. Obviously, easy

access to such information is an incentive to planning careers in surgery and certainly it is desirable in the beginning to encourage a definite plan of training rather than permit the medical graduate to drift from one hospital residency to another or into practice, only to discover later his leaning toward surgery which he can then indulge only at much greater comparative expense because he must sacrifice income. At that late date it has also become more difficult for him to obtain a satisfactory appointment for training.

Discussions of various aspects of graduate training have been published in a number of issues of the *Bulletin*. Most of these have been papers that have been given at the graduate training symposia held during Clinical Congresses. The January 1940, *Bulletin* contains the papers presented at the 1939 Congress, which covered the general subjects of basic science requirements, evaluation of training, and organization and supervision of the educational program.

Also in published form in the October 1939, issue of the *Bulletin* are revised *Criteria for Graduate Training for Surgery*—an outline of the fundamental principles, and a list of 179 hospitals and/or other educational institutions in the United States and Canada which are conducting approved programs.

Thus in its contribution to the literature on the subject, in addition to its direct influence

in promoting graduate training the College has performed a valuable service. The value of the work is enhanced by the fact that theory and opinion have been subordinated to the detailing of findings revealed by actual personal surveys, and to analysis and evaluation of these findings as they bear upon the improvement and better correlation of training programs. Study of actual needs and of actual conditions has preceded every step in the College effort as it has advanced to the point where it has been possible to issue an approved list and to describe acceptable plans. Such study will continue to govern the constant consideration and reconsideration of plans for approval and decisions as to further courses of action.

It would appear that one object of the effort is being realized already in that the number of training places has been increased. If the present rate of increase is maintained for a few years, the needs for opportunities for training, numerically speaking, will be adequately met before long. There will remain, however, ample need for continued exercise of influence, in co-operation with other groups, upon the quality of training afforded. If the art and the science of surgery are to be kept on their onward and upward course, there can be no end to our active concern for the enforcement of constantly rising standards governing the education and training of the surgeon.

FRACTURES AND OTHER TRAUMA

THE AMBULATORY TREATMENT OF FRACTURES OF THE LOWER EXTREMITY

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ABOUT the year 1880 Owen Thomas, of Liverpool, attempted to permit patients who had suffered fractures of the lower extremity, more especially of the femur, to walk with the help of the caliper, which today bears his name, before sufficient time had elapsed for firm union to take place. Thomas' important contributions seem to have been forgotten by surgeons until the time of the war when, under the stimulus of that master surgeon and great gentleman, Sir Robert Jones, the importance of both traction in the treatment of fractures and the value of early protected weight bearing with the help of Thomas' apparatus again became recognized.

It was a simple forward step, following the employment of the Thomas knee splint as a walking caliper, to have suggested the use of a short caliper, reaching not to the tuberosity of the ischium but to the tuberosities of the tibia, as a convalescent appliance in the treatment of fractures of both bones of the leg, about the ankle joint, and of the foot.

The methods introduced by Thomas and Jones were primarily recommended in order that patients, in whom union of bones had progressed to a stage of minimal consolidation, might be able to bear weight without the risk of bending or torsion strains being transmitted to the site of the new callus deposition. Apparently, the first effort to permit weight bearing upon the fractured leg before such consolidation had taken place was attempted by Dollinger, of Budapest, who in 1893 described a method of applying plaster-of-Paris with this end in view. Dollinger recognized the fact that it was possible to apply plaster to the unpadded limb so that weight might be borne from the bottom of the plaster to the tuberosities of the tibia. In order that no weight whatever should be borne by the foot or leg below the site of fracture he placed a layer

of padding beneath the foot and between it and the plaster covering the sole.

Immediately following the first phase of the war, that is about the end of 1918, my attention was directed to the contributions of Delbet, of Paris, who in 1915 had published the description of a method for reducing and fixing fractures of the leg and about the ankle joint. We employed Delbet's method as a convalescent protective apparatus in the case of fractures of both bones of the leg after union had sufficiently consolidated to make it appear reasonable that some weight bearing upon the limb might be attempted, but earlier than it was deemed advisable to run the risk of either bending or torsion strains. An attempt was made to apply Delbet's dressing in both its original manner and in the form as modified by us in the early treatment of fractures especially about the ankle joint. It was found, however, that if Delbet's apparatus was applied soon after the date of injury the limb became dependent, swelling occurred in the foot and at the site of the windows created between the upper right bars and the 2 cuffs. In consequence, if the patients attempted to walk not only was there pain but linear ulcers were likely to be exhibited over the tendo achillis, over the tendon of the tibialis anticus muscle, and at the edges of the windows.

The success which attended the employment of Delbet's dressing in the support of incompletely united fractures of the leg impressed me with the feasibility of employing the upper surface of the upright cone, represented by the malleolus, and the inferior surface of the inverted cone, represented by the tuberosities of the tibia, as a means of transmitting weight from the former to the latter. Early in 1919, therefore, I began the application of plaster without padding in fractures of the foot, about the ankle joint, and of the leg. At the time I was not familiar with the contributions of Dollinger and consequently was not misled into the employment of a pad beneath the foot between it and the plaster

From the Montreal General Hospital
Fracture oration presented before the Clinical Congress of the
American College of Surgeons Philadelphia October 16-20 1939

During the Clinical Congress of the American College of Surgeons in Montreal, in 1926 a number of patients suffering from fractures about the ankle joint and of the os calcis were demonstrated walking in unpadded plaster casts a few days following receipt of injury. Although upon several occasions prior to 1928 addresses were presented before a number of medical societies in which the application of unpadded plasters to permit early protected weight bearing were read, no publication was made describing the technique until August, 1928, at which time I published a paper which had been read before the Academy of Surgery in Philadelphia on March 5, 1928.

These remarks are made at this time because I believe it is true that I have the right to priority in the employment of unpadded plasters in order to make it possible that early protected weight bearing be carried out by patients soon after fractures of the leg, foot, or ankle have been suffered. Since 1928 a number of articles have been published in which the indications for and the contra-indications against the method of application, and the advantages and disadvantages of the method have been described and discussed.

As I have reported on many occasions a description of the technique which we have employed in the application of the unpadded plaster in the treatment of fractures of the foot and about the ankle joint, the procedure will not be described in detail here. I have also discussed what I believe to be the essential differences between my own technique and those of Delbet and Boehler.

Two essentials are required before an unpadded plaster which will permit weight bearing may be applied. In the first place, accurate reduction should be obtained and, in the second, there should be no swelling of the limb whatever. A third desideratum is that the skin be carefully cleansed. We use for this purpose soap and water, alcohol, and a generous coating of zinc stearate powder. If bullae have been present, they are treated as indicated and their neighborhood painted with a suitable skin antiseptic.

If the case is seen immediately following injury and before swelling has taken place, it is possible to apply the unpadded plaster at once. Since, however, it is unusual to see cases before swelling or hematoma formation, there is usually a necessary preliminary fixation period following reduction. As a routine in our clinic we have for many years employed for this purpose the pillow splint which has been described previously. This preliminary fixation period lasts from 2 to 12 days. During this time disappearance of swelling from

the limb is accomplished by raising the foot at the bed and in some cases, by means of the assistance of baking and gentle massage.

A discarded silk stocking, which is always available from the waste baskets in the minor home is drawn over the powdered limb. Although we are quite convinced that the method of application of plaster as advocated by Boehler, Griswold, and others, which is characterized by the application of a posterior molded spiral first and finished by means of circular plaster is good, we have continued to use a circular cast reinforced by a stirrup-like band. This band strengthens the heel upon which weight will be borne, and also the ankle joint which attempts to move. The band extends to above the junction of the middle and lower thirds of the leg, because experience has shown us that this is the part of the apparatus subjected to special strain.

It is evident that in the application of the circular turns care must be exercised so that no constricting bands of plaster be applied and that no dead spaces exist. Since it is of the utmost importance that there be absolutely no swelling of the limb, we are of the opinion that the latter should not be allowed to become dependent during the application of the plaster. Griswold's suggestion that the patient be prone and the leg be flexed at the knee joint is admirable.

Before the cast has set it is carefully molded about the malleoli and to the upper end of the tibia. The foot is fixed at a right angle at the ankle joint and, depending upon the nature of the injury whether external rotation, fibular flexion or tibial flexion, suitable pressure upon the os calcis and astragalus is accomplished to maintain reduction. The mid foot is fixed so that the first and fifth metatarsal heads are on the same horizontal plane and the longitudinal arch of the foot thus reproduced or exaggerated.

Since we have noted that the majority of patients wearing artificial limbs after amputations of the leg prefer to have some of their weight borne upon the lower border of the patella, we have made it a practice to carry the plaster up to this point in front. The posterior border of the cast is cut away sufficiently to permit flexion at the knee to a right angle. Prolonged experience has proved to our satisfaction that it is advisable to include the fifth and usually the fourth toes inside the plaster, because if the plaster stops at the base of the toes, swelling is likely to occur distal to the edge and painful pressure points are consequently likely to ensue.

As soon as the plaster is dry a heel fashioned from saddler's felt 1 to 1½ inches thick is attached

TABLE I—LENGTH OF TIME FOLLOWING INJURY AND START OF LOCOMOTION

	Days
Both bones of the leg	18 to 25
Ankle joint—seen immediately following injury before swelling	1 to 3
Ankle joint—seen after swelling has taken place	5 to 8
Os calcis—reduction usually third to eighth day	10 to 16
Astragalus—astragalectomy for crush fractures	5 to 16
Mid tarsal row—cuneiforms, cuboid, and scaphoid	5 to 8
Tarsal bones	2 to 8
Great toe	1 to 8

to the bottom of the cast with adhesive plaster. The patient is then ready to walk without the employment of crutch or stick.

Private patients have been advised to purchase custom-made boots so fitted as to go over the plaster. Such boots are usually so fashioned that they are not particularly noticeable, and consequently the patient is able to go about his business without being conspicuous. In Montreal the cost of such a custom-made boot is between \$10.00 and \$12.00. For patients who cannot afford such a luxury a cheap slipper-like covering can be made for \$1.00 or thereabouts. Hospital patients provide themselves with either a cheap slipper or a large moccasin. In general, it is inadvisable to allow patients to wear a covering containing rubber over the cast since the moisture which accumulates under these conditions is likely to soften the plaster.

In the treatment of fractures of both bones of the leg we have employed 3 methods. By some of our staff and in certain cases skeletal traction in a Thomas or Braun splint has been employed as an immediate method and continued from 3 to 4 weeks or until early union has commenced. In a smaller number of cases we have used traction and distraction by means of heavy Kirchner wires through the upper border of the tibia and either the lower tibia or os calcis. If such cases have been seen before swelling has occurred, an unpadded cast in which the ends of the wires are incorporated is applied at once and the patient is permitted to start immediate weight bearing. This technique has been employed in transverse fractures in which accurate coaptation of the bone ends has been possible.

Anderson and Griswold have obtained satisfactory results by the employment of pins inserted through the upper part of the tibia and the os calcis. Each has designed an apparatus which is employed for reduction and for fixation of limb pending application of plaster to the skin.

In January, 1935, Griswold reported his results over a one year period ending June, 1934. Of 67 fractured legs, the double pin technique was employed in 43. In the remainder, except for a small number of severe compound fractures, manual reduction and unpadded casts were employed without pins. The results were, in Griswold's opinion and with which I heartily agree, extremely satisfactory. He was also able to state that the period of hospitalization including both simple and compound fractures had been reduced to an average of less than 10 days.

Our routine method, however, has been to carry out reduction by means of traction, em-

ploying for this purpose what we have considered to be our own modification of Delbet's sling. By means of this sling which grasps the os calcis at the point of attachment, the tendo achillis, and the astragalus just distal to the ankle joint, it is possible for the assistant to maintain traction by means of his body weight transmitted through the upper arm and at the same time to have both hands free for manipulation of the foot.

If swelling is present at the time the reduction is carried out, a single layer of sheet wadding is applied to the limb, particular care being taken that not more than one layer be applied over the upper portion of the tibia or about the malleoli. Circular plaster-of-Paris is applied with the sling in position. Care is taken to mold the plaster accurately to the cone represented by the malleoli and to the upper border of the tibia. The first plaster is applied with the knee joint flexed about 15 degrees and reaches to the junction of middle and upper thirds of the thigh. Since by this technique it is difficult to prevent posterior bowing at the site of fracture unless the foot is kept in moderate plantar flexion, this position is adopted.

When the plaster has set, the sling is removed from the foot in order that pressure points arising from its incorporation in the plaster under tension may not take place. Removal of the sling is usually accomplished without much difficulty by slipping a pair of bandage scissors between plaster and skin and cutting the loops. The whole sling is then withdrawn. Following the removal of the sling a few turns of plaster are applied so that the space in the sole of the foot may be covered.

The patient is returned to bed with the foot of the latter raised a distance of 8 or 10 inches in order that adequate circulation may be established as promptly as possible. On about the twenty-first to the twenty-fifth day the anterior half of the cast is removed and the site of fracture and limb as a whole investigated with special reference to the condition of the skin and the presence or absence of swelling. It is usually discovered at this time that the bone ends are

sufficiently fixed to prevent displacement and to permit movements of knee and ankle joints. At this time we customarily employ gentle massage and baking for a few days and induce the patient to attempt movements of the ankle joint to bring about dorsiflexion of foot to at least a right angle.

As a rule, on the twenty fifth to the twenty eighth day following injury we have found that absolutely all edema has subsided and that fixation at the site of fracture has become sufficiently stable to permit dorsiflexion of the foot without any tendency toward displacement or bending. A walking unpadding plaster is then applied over a silk stocking, according to the technique described for fractures of the foot and ankle, but it is extended to about the junction of the middle and upper thirds of the thigh. Since, on the one hand, there is no necessity for the plaster fitting snugly to the skin above the knee joint, and on the other hand, on account of the ease with which the thigh tissues are molded, no attempt is made to make the plaster fit snugly at this point, 1 or 2 layers of either sheet wadding or flannelette are applied between the plaster and the skin above the knee joint. Just before the plaster finally sets this upper border is turned down so that no cutting edge will be produced. The reinforcing plaster-of Paris stirrup is carried well above the site of fracture so that strain on the circular plasters at this point will be minimized. As soon as the plaster has dried a felt heel is fixed to the bottom of the plaster as recommended for fractures of the foot and ankle.

We have felt that it is rather important when the patient first begins to walk that he be instructed as to the proper gait to employ. Since the knee and ankle joints are complementary he is advised that whether the fixation extend above the knee or not no useful purpose is gained by attempting to flex the knee joint in walking. He is instructed to keep the injured limb at all times in front of its fellow so that he steps forward whatever distance is convenient with the plaster encased foot and brings the normal foot up to but not past the injured member.

ADVANTAGES AND DISADVANTAGES OF DIFFERENT METHODS

From the patient's point of view there are many unfavorable features which may follow fracture of one or more of the bones of the lower extremity. These are (1) Pain and possible shock to the nervous system (2) loss of time (3) expense of treatment, with special reference to hospital and surgical fees and possible apparatus, and (4) persistence of disability either for a long time or

permanently. Prolonged or permanent disability may be due to deformity, delayed union, non-union (pseudarthrosis), interference with joint function, contractures and consequent interference with action of muscles and tendons, circulatory disturbance as manifested by swelling and loss of tolerance to low temperatures, and painful foot due to atrophy of bone and ligamentous structures of either acute or chronic type.

Those who are familiar with the technique of plaster application and postoperative treatment of patients who have suffered fractures below the knee believe that the above unfavorable concomitants or sequelae are in large measure avoided by the use of a technique which permits early protected weight bearing.

Pain and shock to nervous system. Since it is possible for such persons to be out of bed fully dressed and to carry on many or most activities within a few days after injury the effect upon morale is striking. The natural effects of such improvement in morale are to minimize the incidence of that train of symptoms commonly referred to as traumatic neuroasthenia or even that more subtle symptomatology known as *sinistrosis*.

Loss of time. By means of the application of unpadding plaster to the injured limb it is possible for professional and business men to return to full activity within a few hours after the time of injury in the case of fractures of the foot or about the ankle joint, or within a month in the case of fractures of the leg. The above refers to results in cases in which operative methods in the sense of piano wire or pin fixation are not used or at an earlier date if such methods are instituted (Griswold, Anderson).

Although we have not employed in our clinic any of the methods, especially that of Anderson, which make possible early protected weight bearing in the case of fractures of the shaft of the femur it would seem that such a contribution as that made by Anderson is the inevitable result of improvements in the treatment of fractures below the knee by a similar technique. Since Anderson's description of his technique seems to prove the mechanical reasonableness of the multiple pin method, and since the results reported by him and the comparatively small number of surgeons who have employed his method are so satisfactory and apparently free from risk, it would seem likely that in the near future in certain selected cases, at least, we will find persons in wide spread parts of the continent returning to full occupation within a few days after having suffered a fracture of the shaft of the femur.

Although immediately following the introduction by Smith-Petersen, of Boston, of the flanged nail there was a somewhat general belief engendered that such fixation would permit early weight bearing, and although, in fact, in many cases the results of partial weight bearing assisted by crutches were satisfactory, I believe I am correct in stating that today the majority of surgeons have reached the conclusion that attempts at walking with weight bearing upon the injured limb in less than 3 to 4 months from the date of accident is inadvisable unless additional methods of protecting the injured bone are instituted.

In addition to business men, clerical workers, physicians, surgeons, and members of the legal profession who, as here indicated, are able to return to their usual activities almost immediately following fractures at least below the knee, housewives and mothers are usually able to carry on with their necessary duties with only a short period of absence from the home. Again, in so far as household activities are concerned the fact that domestic servants have to remain away from work for only a few days in consequence of a fractured ankle or broken foot is of importance both in that the routine of the household is not disturbed and, in so far as the injured individuals themselves are concerned their employment is maintained. Moreover, pupils and students at schools and universities are able to carry on with little time loss. In this connection, too, I should like to express the opinion that contrary to the general belief the value of such young people's time is equally if not more important than that of older persons.

Until such time as Workmen's Compensation Boards and insurance companies have the matter placed before them in an adequate fashion by their surgical advisers it will not be possible for employees to return to work until final consolidation of fractures and return of function has been obtained. Nevertheless, the very fact that with the speeding up in industrial operations the number of accidents is likely to increase will, I believe, make it imperative before long that on the one hand savings to industry and, on the other hand, increased earning capacity on the part of the employee shall draw forcibly to the attention of both commission and insurance company the importance of demanding that patients with fracture at least below the knee be treated in a manner similar to that recommended in this contribution. If, as seems probable, a shortage of labor in all directions in consequence of war activities becomes acute, there will be an added demand for the shortest possible period of lay-off,

particularly in the case of skilled workers. Unfortunately, in consequence of the past 10 years of inadequate employment the supply of skilled workers has become lamentably short.

Expense of treatment. Recent data with regard to the expense to the community, the individual, or other organization responsible, have shown that the greater part of the expenditure is on account of hospital erection and upkeep. If improvement in surgical care is to result in better end-results and a shortening of both temporary total and temporary partial disability, there seems to be no reason why surgical fees for the care of individual fractures should in any way be reduced. If it be possible, and it is, to treat 3, 6 or 8 persons rather than only 1 individual with the employment of but 1 bed, it is evident that the erection of new hospitals will be minimized. It is true, of course, that the more intensive the active treatment which is carried out, as is the case when a rapid turnover takes place, the cost per bed per day is increased, nevertheless, in the long run the cost of hospitalization in so far as fractures of the lower extremity are concerned, has been and will be enormously reduced.

Although there will, I believe, always be a certain demand for the employment of those procedures which are grouped under the heading of physiotherapy in a small selected group of cases, it immediately becomes evident as soon as a method of early protected weight bearing is employed that the necessity for prolonged employment of physiotherapy is either completely eliminated or much reduced.

Persistence of disability. With reference to the persistence of disability either for a long time or permanently, and this refers equally to men coming under Workmen's Compensation Commissions and to business executives, professional men, and others, this may be considered under 3 separate headings: (1) total temporary disability, (2) temporary partial disability, and (3) permanent partial disability.

Since total temporary disability is reduced for many classes of persons to the matter of hours or days for fractures of foot and ankle, and approximately to only 4 weeks for fractures of both bones of the leg, this feature of such fractures is in large measure eliminated. This is true although temporary partial disability does, in fact, to a certain extent take its place, although for many persons the disability suffered while the protective plaster is being worn is more theoretical than real. Although permanent partial disability following fractures will never be completely eliminated because the original trauma not infre-

sufficiently fixed to prevent displacement and to permit movements of knee and ankle joints. At this time we customarily employ gentle massage and baking for a few days and induce the patient to attempt movements of the ankle joint to bring about dorsiflexion of foot to at least a right angle.

As a rule, on the twenty fifth to the twenty eighth day following injury we have found that absolutely all edema has subsided and that fixation at the site of fracture has become sufficiently stable to permit dorsiflexion of the foot without any tendency toward displacement or bending. A walking, unpadded plaster is then applied over a silk stocking according to the technique described for fractures of the foot and ankle, but it is extended to about the junction of the middle and upper thirds of the thigh. Since, on the one hand, there is no necessity for the plaster fitting snugly to the skin above the knee joint, and on the other hand, on account of the ease with which the thigh tissues are molded, no attempt is made to make the plaster fit snugly at this point, 1 or 2 layers of either absorb wadding or flannellets are applied between the plaster and the skin above the knee joint. Just before the plaster finally sets this upper border is turned down so that no cutting edge will be produced. The reinforcing plaster-of-Paris stirrup is carried well above the site of fracture so that strain on the circular plasters at this point will be minimized. As soon as the plaster has dried a felt heel is fixed to the bottom of the plaster as recommended for fractures of the foot and ankle.

We have felt that it is rather important when the patient first begins to walk that he be instructed as to the proper gait to employ. Since the knee and ankle joints are complementary he is advised that whether the fixation extend above the knee or not no useful purpose is gained by attempting to flex the knee joint in walking. He is instructed to keep the injured limb at all times in front of his fellow so that he steps forward whatever distance is convenient with the plaster encased foot and brings the normal foot up to but not past the injured member.

ADVANTAGES AND DISADVANTAGES OF DIFFERENT METHODS

From the patient's point of view there are many unfavorable features which may follow fracture of one or more of the bones of the lower extremity. These are (1) Pain and possible shock to the nervous system (2) loss of time (3) expense of treatment, with special reference to hospital and surgical fees and possible apparatus, and (4) persistence of disability either for a long time or

permanently. Prolonged or permanent disability may be due to deformity, delayed union, non-union (pseudarthrosis), interference with joint function, contractures and consequent interference with action of muscles and tendons, circulatory disturbance as manifested by swelling and loss of tolerance to low temperatures, and painful foot due to atrophy of bone and ligamentous structures of either acute or chronic type.

Those who are familiar with the technique of plaster application and postoperative treatment of patients who have suffered fractures below the knee believe that the above unfavorable concomitants or sequelae are in large measure avoided by the use of a technique which permits early protected weight bearing.

Pain and shock to nervous system. Since it is possible for such persons to be out of bed fully dressed and to carry on many or most activities within a few days after injury the effect upon morale is striking. The natural effects of such improvement in morale are to minimize the incidence of that train of symptoms commonly referred to as traumatic neuroasthenia or even that more subtle symptomatology known as *subtrosta*.

Loss of time. By means of the application of unpadded plaster to the injured limb it is possible for professional and business men to return to full activity within a few hours after the time of injury in the case of fractures of the foot or about the ankle joint, or within a month in the case of fractures of the leg. The above refers to results in cases in which operative methods in the sense of piano wire or pin fixation are not used or at an earlier date if such methods are instituted (Griswold, Anderson).

Although we have not employed in our clinic any of the methods, especially that of Anderson, which make possible early protected weight bearing in the case of fractures of the shaft of the femur it would seem that such contribution as that made by Anderson is the inevitable result of improvements in the treatment of fractures below the knee by a similar technique. Since Anderson's description of his technique seems to prove the mechanical reasonableness of the multiple pin method, and since the results reported by him and the comparatively small number of surgeons who have employed his method are so satisfactory and apparently free from risk, it would seem likely that in the near future in certain selected cases, at least, we will find persons in wide spread parts of the continent returning to full occupation within a few days after having suffered a fracture of the shaft of the femur.

Although immediately following the introduction by Smith-Petersen, of Boston, of the flanged nail there was a somewhat general belief engendered that such fixation would permit early weight bearing, and although, in fact, in many cases the results of partial weight bearing assisted by crutches were satisfactory, I believe I am correct in stating that today the majority of surgeons have reached the conclusion that attempts at walking with weight bearing upon the injured limb in less than 3 to 4 months from the date of accident is inadvisable unless additional methods of protecting the injured bone are instituted.

In addition to business men, clerical workers, physicians, surgeons, and members of the legal profession who, as here indicated, are able to return to their usual activities almost immediately following fractures at least below the knee, housewives and mothers are usually able to carry on with their necessary duties with only a short period of absence from the home. Again, in so far as household activities are concerned the fact that domestic servants have to remain away from work for only a few days in consequence of a fractured ankle or broken foot is of importance both in that the routine of the household is not disturbed and, in so far as the injured individuals themselves are concerned their employment is maintained. Moreover, pupils and students at schools and universities are able to carry on with little time loss. In this connection, too, I should like to express the opinion that contrary to the general belief the value of such young people's time is equally if not more important than that of older persons.

Until such time as Workmen's Compensation Boards and insurance companies have the matter placed before them in an adequate fashion by their surgical advisers it will not be possible for employees to return to work until final consolidation of fractures and return of function has been obtained. Nevertheless, the very fact that with the speeding up in industrial operations the number of accidents is likely to increase will, I believe, make it imperative before long that on the one hand savings to industry and, on the other hand, increased earning capacity on the part of the employee shall draw forcibly to the attention of both commission and insurance company the importance of demanding that patients with fracture at least below the knee be treated in a manner similar to that recommended in this contribution. If, as seems probable, a shortage of labor in all directions in consequence of war activities becomes acute, there will be an added demand for the shortest possible period of lay-off,

particularly in the case of skilled workers. Unfortunately, in consequence of the past 10 years of inadequate employment the supply of skilled workers has become lamentably short.

Expense of treatment. Recent data with regard to the expense to the community, the individual, or other organization responsible, have shown that the greater part of the expenditure is on account of hospital erection and upkeep. If improvement in surgical care is to result in better end-results and a shortening of both temporary total and temporary partial disability, there seems to be no reason why surgical fees for the care of individual fractures should in any way be reduced. If it be possible, and it is, to treat 3, 6 or 8 persons rather than only 1 individual with the employment of but 1 bed, it is evident that the erection of new hospitals will be minimized. It is true, of course, that the more intensive the active treatment which is carried out, as is the case when a rapid turnover takes place, the cost per bed per day is increased, nevertheless, in the long run the cost of hospitalization in so far as fractures of the lower extremity are concerned, has been and will be enormously reduced.

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quently causes injuries to essential soft tissues as well as to bones and although early protected weight bearing will not take the place of skillful early reduction it is nevertheless true we believe, that many of the causes for permanent partial disability are avoided by the employment of the unpadded plaster and immediate weight bearing and locomotion upon the injured limb

CAUSES OF PROLONGED OR PERMANENT DISABILITY

The causes of prolonged or permanent disability have been stated. However it is in order I believe to make the following remarks

1. It is evident that with regard to deformity immediate skillful treatment with exact anatomic reduction of displacement as nearly as possible is of paramount importance. It is also true that in too many patients deformity particularly of fractures about the ankle joint, develops secondarily as the result of too early unprotected weight bearing upon the injured limb. Since patients, who are able to carry on more or less completely with their usual occupations, are much less likely to complain of the length of time required for complete consolidation, this secondary cause of deformity is not likely to complicate the progress of the case.

2. The question of delayed union is one which has been discussed in a large measure in the preceding paragraph. I wish however to make the statement that in my opinion the fact that in practically all textbooks on general surgery the length of time indicated for sound consolidation in fracture repair is too short. Sufficient attention has not been paid by many surgeons to the differentiation of early fixation by provisional callus at the site of fracture and consolidation of sufficient strength not only to bear weight but to resist torsion and bending strains. There can be no doubt in my opinion that many patients are subjected to operation for bone grafting or perhaps other procedures with a diagnosis of delayed union on account of the optimism on the part of the attending surgeon regarding length of time required for consolidation of certain fractures.

3. Non-union or pseudarthrosis with definite adventitious bursa formation in consequence of liquefaction of the osteoblastematous tissue unquestionably occurs and is exhibited at one stage during the course of bone repair. We all have seen such cases nor is there any difference in opinion as to the necessity in such cases of somewhat radical interference with view to removing the tissue between the bone ends and usually the insertion of bone graft. I believe I am correct

in making the statement that the incidence of pseudarthrosis in those patients treated by surgeons, who have become familiar with the technique of early protected weight bearing, has been enormously less than that encountered by surgeons who have continued to treat fractures by other methods. Our long experience of approximately 20 years in the treatment of hundreds of fractures of the ankle joint and leg by means of the unpadded cast and early protected weight bearing has resulted in but one case of non union, although during the same period many cases of non-union have been referred to us which had been treated by other methods.

In my previous contribution I referred to an article by Kuentzler which unfortunately so far as I know has not been confirmed by English or American investigators. In this article Kuentzler indicates that experiments by himself and others, more especially Kompecher have proved that if during bone repair the new callus is kept under the influence of traction, pseudarthrosis is the result, but if under the influence of pressure bony union may be expected. In other words, by pulling the fragments asunder fibrous union results and by pressing them together bony union ensues. Although in a properly applied walking plaster but little weight is borne upon the bone ends, unless serious errors in technique have been made there is but little likelihood of distraction.

Many of us are of the opinion that walking upon the fractured limb results in stimulation of bone consolidation in the same manner as that procedure introduced by Owen Thomas and popularized by Sir Robert Jones, namely, that of exposure and hammering the bone ends in cases of non-union.

4. Space limitations do not permit consideration of the various factors which result in interference with joint function which follow fractures and the more or less inevitable and necessary period of fixation. It would seem evident however that at least a important factors have as influence upon such unfavorable sequelae. On the one hand the peri-articular structures, ligaments, tendons, and tendon sheaths, as well as other less specific soft structures have a tendency to contract to the position maintained during the period of rest. It is for this reason that a number of surgeons prefer to employ a method which can be described best as that of early mobilization (de Champonnière, Menell and others). The second important reason, in my opinion, for interference with joint function with the development in some cases of actual ankylosis is that of atrophy of cartilage and ligamentous structures which we be-

heve takes place *pari passu*, with the invariable though usually minimal decalcification of the bones about the site of fracture

As the result of weight bearing during healing adequacy of the blood supply to the injured limb is usually maintained, in consequence, atrophy of cartilage, ligament, and bone is minimized and loss of joint function due to this cause is avoided. In so far as the tendons are concerned, although no movement is possible in a well applied cast, these structures attempt to move and, in fact, do move within a limited range. In any event it is unusual when fixation is removed to find any considerable loss of joint function. If the position of the joints has been properly provided for prior to fixation, it usually requires only a few minutes of active movement before complete return of function is established.

5 Contractures and interference with action of muscles and tendons has been referred to in the last section. The fact that marked muscle atrophy occurs with shortening of the musculotendinous systems, which are placed at rest during the fixation period, is recognized by everyone who has treated patients with fracture of the lower extremities either in bed or on crutches with a dangling limb. Although a properly applied, unpadded plaster cast so fixes the joints of the limb that practically no movement takes place, such fixation does not prevent contraction and sliding of the muscles and, to a lesser degree, of the tendons. [The fact that muscles which are induced to exercise against a fixed restraining force may be kept normal in size and activity is well known. Incidentally, the contracture of such muscles is of importance in stimulating a more nearly normal blood circulation through the limb as a whole.]

6 Circulatory disturbances, when the limb first becomes dependent after prolonged bed rest or following the removal of a padded plaster cast, are such common phenomena that they need hardly be referred to here. [Perhaps the most striking observation which will be noted by the surgeon, who has not previously used unpadded casts with early weight bearing, will be the fact that following removal of fixation the amount of swelling which takes place in the limb is rarely more than minimal, since the application of a plaster about the limb after the latter has been completely freed from interstitial fluid evidently prevents stretching of the interstitial spaces and protects the valves of veins and lymphatics from strain. At the same time stasis of blood in the capillaries and smaller vessels is rendered im-

possible. The necessity, therefore, for prolonged protection of the limb following removal of plaster is not necessary nor do such patients complain of discomfort during cold weather.]

✓ The author has upon several occasions published contributions regarding the condition which is described as acute bone atrophy and to which Sudeck's name has been applied. It is not my intention at this time to dilate upon what I believe to be the causes of the exhibition of this condition nor to discuss in detail its prevention or treatment other than to say that in our experience the most favorable treatment for the condition, when exemplified in the lower extremity, is the application of a walking cast and the resumption of active function in so far as weight bearing is concerned. The comparatively large number of cases of this extremely disabling condition, the prolongation of disability among patients who have been treated either in bed or, more especially with a dangling limb, and the almost complete absence of this complication among our own cases has convinced me that acute bone atrophy in the lower extremity is more surely avoided by the use of a technique which permits protected weight bearing during the period required for consolidation of the fracture.

The advantages of early protected weight bearing have been indicated at some length. The disadvantages are primarily two. The less important of these is that a certain amount of skill in the application of the unpadded plaster is evidently required. This, however, is not a difficult matter. The second objection is, I believe, more important. With few exceptions the patient must be admitted to the hospital and, except in the occasional case which is seen prior to the development of swelling, bed rest with suitable support and posture must be available for a few days until all interstitial fluid in the affected limb has been dissipated. I believe, moreover, that re-admission to the hospital for change of plaster when the latter wears out will in the long run prove more satisfactory and consequently desirable.

A sufficiently large number of patients have been seen who have worn the iron stirrup type of heel such as has been recommended by Boehler, and also the felt heel as recommended by me to be able to state with assurance that patients who have worn both forms of apparatus are unanimously in favor of the felt heel both as far as actual ease of locomotion is concerned and specifically with regard to the wearing of a suitable boot or other foot covering.

PRIMARY AND SECONDARY TENDON SUTURE

A Discussion of the Significance of Technique in Tendon Surgery

MICHAEL L. MASON, M.D., F.A.C.S., Chicago, Ill nos

DISCUSSION of surgical technique is often considered to belong more to the art than to the science of surgery, however in tendon repair correct technique based upon principles derived both from experimental data and clinical observation, is imperative if we hope to secure primary undisturbed healing. We have busied ourselves a great deal with the factors and safeguards which make for complete asepsis. Dressings and other supplies are checked and rechecked, safeguards and rules provide the utmost assurance humanly possible that sterile and aseptic mean exactly that. But we have been so occupied with the bacteriological side of surgery that we have tended to neglect the technique of handling tissues. It is of course important that no bacteria be introduced into wounds, that possibly even the air in the operating room be sterilized but it is also important that the surgeon does not kill or impair the vitality of living cells. Unless the surgeon is willing to take the time and has the patience to work slowly and carefully to develop what Bunnell has so aptly called the "traumatic technique," he cannot hope to secure successful results in the surgery of tendons of the hand. In few fields of surgery do minor disturbances of wound healing interfere so seriously with the end-result as in tendon repair.

Much has been said about the gentle handling of tissues but until we analyze just what we mean, we are likely to go on crushing, bruising and devitalizing tissue without realizing that methods of handling tissues, which may yield satisfactory healing in such procedures as herniotomy or appendectomy may prove a complete failure in the case of tendon surgery. Small bits of necrotizing tissue distal to ligatures, small hematoma and collections of serum, even an occasional stitch abscess, if these do not give rise to serious infection, may not impair the result of a herniotomy. However such is not the case when we come to the repair of tendons. The great complexity of the tissues of the hand the lowered

temperature because of its peripheral situation, and its vulnerability to infection, coupled with the peculiarities of healing of tendon itself make this field a difficult one in which to obtain primary healing. Each step in the handling of tissue from preparation of the skin to closure and application of the dressing and splint is important and has evolved often we must confess, rather by painful trial and error than by intelligent prescience.

The instruments and suture material are relatively simple. Few if any special instruments are required. The large tissue forceps, hemostats, and needles so commonly used, however are too coarse for tendon repair and heavy ligatures and sutures cannot be used. Hemostats of the mosquito or Habesed variety without teeth enable the surgeon to catch bleeding vessels accurately without grasping large amounts of surrounding tissue. Fine tissue forceps with teeth, such as Adson forceps, are excellent for handling tissues, while very fine tissue forceps without teeth are useful in picking up the delicate nerve or tendon sheaths. Senn retractors with small narrow smooth blades on one end and fine cat-paw on the other and a second type of small ribbon retractors with somewhat broader blades, are very useful. Aneurysm needles and fine curved ligature carriers are valuable for passing tendons, boat bones, as are also small Reverdin needles with blunt ends. Fine bladed spatulas often serve well for retracting tendons, nerves, and blood vessels during dissection. Scissors of the manure type enable the surgeon to cut silk ligatures close to the knot. For suture and ligature material there is no doubt in my mind as to the advantages of plain untreated silk. There is some lack of clarity however as to the sizes of silk which should be used in tendon repair. Much of this confusion is due to the fact that manufacturers of surgical silk do not follow a uniform system of identifying sizes. Some brands go by letters and some by numbers, and very seldom do we find any two identical. The silk should be fine much finer than any catgut, except possibly No. 0000 or 00000 catgut. Size A Corticell sewing silk, or even finer in this or other brands is strong enough for ligatures, for subcutaneous closure, and even for suturing tendon when little tension is expected

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When a stronger tendon suture is required, size D in Corticelli or a similar or even somewhat finer suture in one of the so called surgical silks is sufficiently strong. For very fine appositional sutures, especially for nerve suture and for appositional tendon sutures the No 000000 black silk on straight atraumatic needles is excellent.

The needles should also be small so as to cause a minimum disruption of the tissues. Short straight Carrel arterial needles are excellent for introducing the tension sutures into the tendon. Fine round needles are occasionally valuable in tendon repair in a limited space and are used for subcutaneous closure.

For too long a time our entire concept of skin preparation has been an attempt to sterilize it by means of germicidal chemicals, and the test of the efficiency of an antiseptic agent was its ability to kill bacteria in the test tube. For a long time we quoted the values of antiseptics in phenol equivalents, disregarding its irritative action on the skin or its effect on healing afterwards. The efficacy of skin preparation is determined by taking cultures from the surface and evaluating the antiseptic according to the number of bacterial colonies which appear after its use. It appears to me that the real test of the efficacy of skin preparation is postoperative healing. No matter how carefully the skin is prepared it does not remain sterile long, we depend eventually upon the skin itself to protect the tissues from external noxious influences. Regardless of bacterial cultures we are looking for healing and not necessarily for sterility *per se*. Obviously a skin antiseptic cannot be perfect, chemical sterilization of steel is nearly impossible and it has been shown that chemical sterilization of catgut is not reliable. We should, therefore, prepare the skin in such a way that while we remove as many bacteria as possible, we still do not injure it so that it can no longer cope with organisms present.

Studies carried out by Koch on the comparative efficacy of skin preparation in clean cases, in which the nature of postoperative healing has been taken as the criterion, have shown quite definitely that there are fewer wound disturbances with soap and water preparation of the skin than following tincture of iodine, picric acid, or other commonly used agents. A similar study, made by Allen, Gibbs, and myself, of 881 "clean" appendectomies in a consecutive series of 1000 cases at Passavant Memorial Hospital, has shown that wound infection or disturbance in healing occurred 14 times or 3.00 per cent of 466 cases following iodine and alcohol preparation, 2 times or 1.03 per cent of 194 cases following picric

TABLE I—DISTURBANCES OF WOUND HEALING IN 881 CONSECUTIVE "CLEAN" APPENDECTOMIES

Skin preparation	No of cases	Cases with wound disturbance	Per centage
Tincture of iodine	466	14	3.00
Picric acid	194	2	1.03
Soap and water	221	1	0.54

Table Correlation between wound healing in 881 clean appendectomies in a total of 1000 consecutive cases. Included are all disturbances in wound healing, all serious and trivial infections, serous or bloody discharge of over 48 hours duration, etc.

acid, and once or 0.54 per cent of 221 cases following soap and water preparation of the skin.

Obviously, when so many factors have to do with wound healing, we cannot claim that a lowered incidence of wound disturbance can be ascribed to the skin preparation alone. It is evident, however, that the use of soap and water has not been associated with an increased number of wound infections, but that, on the contrary, primary healing has taken place in over 98 per cent of patients so prepared. The absence of irritative phenomena, the natural appearance of the skin, and the reactionless postoperative healing following careful washing with soap and water are so much of a satisfaction to the surgeon that I doubt if he would give it up. It must be understood that the soap is not simply painted on the skin in the same fashion as an antiseptic. It is used in no way as an antiseptic, it is used to cleanse the skin mechanically. This manner of preparation is somewhat more time-consuming than painting with an antiseptic, it requires a full 10 minutes just as does surgical scrubbing of the hands and should be done as thoroughly and carefully. It cannot be done with a stiff brush or coarse gauze but with soft cotton. The soap should be non-irritating, the tinctures and various germicidal varieties are much inferior to the simple, white, cake soap. Except in case of emergency it is well to give the hand a preliminary washing in warm, soapy water for about 20 minutes the day before operation, to rinse the hand in warm sterile water, and to cover it with a sterile dressing. Preceding the cleansing the hand is shaved if necessary and particular attention should be paid to the nails which are cut short and cleansed with nail file and brush. Preparation of the skin in this manner provides the surgeon with a surgically clean field untraumatized by antiseptics through which he may safely perform an extensive surgical repair.

There are certain principles to be followed in making primary incisions, in enlarging wounds, or excising scars of previous procedures. In gen-

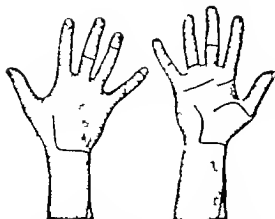


Fig. 1 Skin incisions on the hand should follow the midline and should follow as closely as possible the lines of skin creases. They should be planned so as to produce flaps which overlie the site of nerve and tendon suture.

eral incisions on the hand are made in such a way that the resultant scar does not contract and lead to loss of function. If possible, we must avoid scars in the midline of fingers or wrist, and scars which run at right angles to flexion creases. Incisions should be so planned that the line of tendon repair is overlaid by a flap provided with a generous amount of subcutaneous tissue and not by the line of skin suture. For example, the tendons in the carpal tunnel are exposed by a bayonet-shaped incision (Fig. 2). The palmar limb of the incision follows or is parallel to one

of the longitudinal palmar creases at the wrist. It continues transversely parallel to or along a transverse carpal crease to the radial or ulnar border of the wrist. From the wrist it continues upward on the medial or lateral side of the forearm curving slightly toward the midline. If the surgeon exerts gentle traction with sponges on the skin while cutting through it, the subcutaneous vessels may be seen, grasped with fine hemostats, divided, and ligated as the incision is deepened (Fig. 3). The skin incision is carried deeply through the subcutaneous and deep fascia so that the flap is provided with a thick vascular and fatty layer of tissue to provide both a good blood supply for the skin and a good subcutaneous covering over the underlying site of repair. While raising the flaps the skin is handled as gently as possible. It should not be crushed with hemostats or tissue forceps. With a little practice the skin can be retracted with one blade of a tissue forceps, a technical point which we have learned from Barrett Brown. It is seldom necessary to grasp the skin except occasionally during closure.

Incision on the dorsum of the wrist is similar to that on the volar surface (Fig. 1) i.e., a radial or ulnar longitudinal incision over the metacarpus, a transverse incision across the carpus, and a longitudinal continuation upward on the forearm. Exposure of tendons in the palm should be made if possible through a transverse incision in the distal part of the palm and through a longitudinal incision in the proximal part. Exposure of tendons in the fingers follows the same principles. Flaps should be made here also, and this may be accomplished by combining lateral longitudinal with transverse incisions. The guide points for the lateral incision are the ends of the transverse digital creases which insure that the incision lies well back from the volar surface. We may uncover the whole of the tendon in the finger by a single longitudinal incision, but it is better to cross the finger transversely near a flexion crease and continue the longitudinal incision along the opposite side. By combining such an incision on the finger with a transverse incision in the palm we can uncover the whole digital course of the flexor tendons and be provided with a good skin and subcutaneous flap to cover them. Exposure of the flexor tendon of the thumb is made on the same principle, as are also incisions for exposure of the extensor tendons on the dorsum of the fingers.

It is usually the case, however, that instead of elective incisions the surgeon must make compromises either with a wound already present or with a scar and must adapt the exposure to the conditions present. The surgeon must still avoid the midline strive to secure flaps to cover the

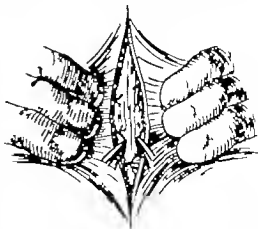


Fig. 2 While making the skin incision the surgeon exerts traction on the skin exposing the subcutaneous vessels which are clamped, divided, and ligated.

site of operation, and provide these flaps with as much subcutaneous tissue as possible. Each situation is different and the surgeon's ingenuity often is taxed to find the best solution to the problem. A few examples will show the possibilities of such adaptation. The most frequent wounds of the fingers and wrist are transverse and are seldom of sufficient size to allow adequate exposure and repair (Fig 3). To enlarge them, as is so frequently done, by a longitudinal incision transverse to the center of the laceration is a grievous error, since it produces a crucial wound with 4 flaps which come together in a point at the center. The tips of these flaps are difficult to oppose accurately, are poorly vascularized, and tend to become necrotic. The longitudinal line of skin closure following such a procedure directly overlies the site of tendon repair and contracts during healing.

Enlargement of an original transverse wound may be made by means of longitudinal incisions distally and proximally from either end of the original wound. If it is necessary to cross the carpus and go down into the palm, this may be done, as outlined, by a transverse incision parallel to one of the carpal creases and continued as a longitudinal incision on the hand. A transverse wound on the fingers or in the palm also may be enlarged by longitudinal incisions from one or both ends of the original wound.

In the case of scars from the original wound or following previous operations, the problem may

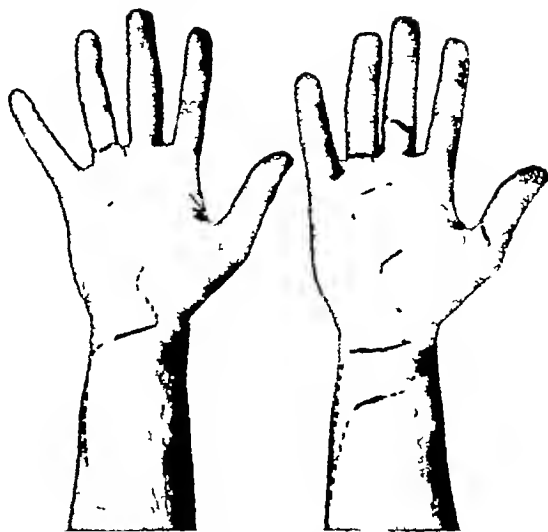


Fig 3 Wounds of the hand and forearm are usually transverse and may be enlarged to provide better access by incisions from either end, as indicated by dotted lines.

be more complicated (Fig 4). It may be advantageous to include the scar in the incision (Fig 4a) and in this instance the cutaneous scar should be excised back into healthy tissues so that the resultant skin edges are soft and are provided with a good layer of subcutaneous fat. At times it may be advantageous to ignore the original scar altogether and make the exposure through

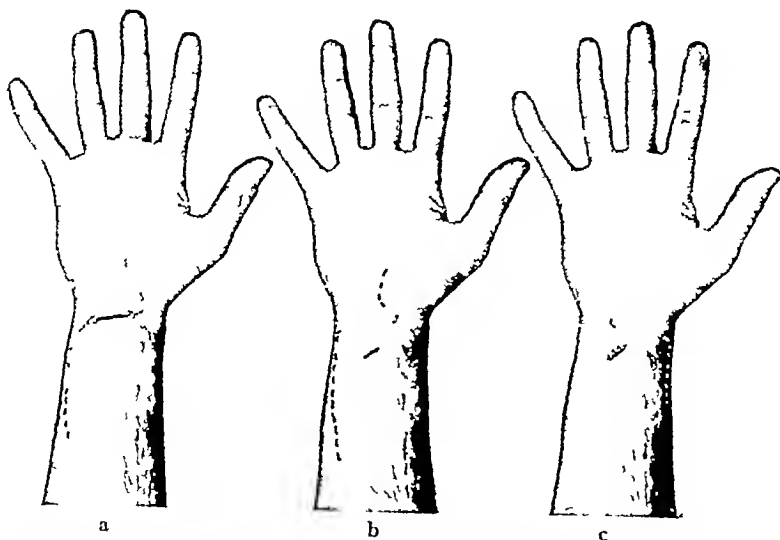


Fig 4 a, A scar from a previous operation may be incorporated in the incision, b, it may be ignored and the incision may follow the line of choice, c, the scar may be excised and resutured and the incision of choice made.

the site of election (Fig. 4b). In such cases the scar will be situated on one of the flaps and will be undermined in raising the flap. Care is necessary in undermining the scar so that the surgeon does not injure adherent nerves and tendons on the one hand or leave the scar too thin on the other thus compromising the blood supply and running the danger of necrosis. It may be wise occasionally if the scar is very thin, to excise and suture it rather than risk its subsequent necrosis (Fig. 4c).

Careful hemostasis is necessary not only for good visualization of the operative field but also for the prevention of hematomas and oozing into the tissues after closure. Frequent sponging should be avoided, since no matter how carefully we sponge and avoid wiping the operative field, a certain amount of tissue damage is done. In the case of the hand we are able to maintain a bloodless field as long as necessary to perform even the most extensive repair. By means of a blood pressure apparatus the surgeon can control bleeding, can maintain a definite known pressure over a broad area of the arm, and can release and reapply it at will. I cannot say just how long the pressure of 150 to 200 millimeters of mercury can be maintained, but we have never found it necessary to release it until the operation has been completed. The amount of pressure necessary to control hemorrhage varies somewhat from patient to patient but is usually 150 to 200 millimeters of mercury even in young children. The pressure is not continued without interruption for the 3 or 3 hour period of the operation. It is interrupted, however, in the interest of hemostasis rather than because we fear its continuous maintenance. During an operation under sphygmomanometer hemostasis of 150 millimeters of mercury blood vessels are visualized, venous oozing appears, and bleeding points are grasped and ligated as the operation proceeds. As soon as the dissection has been completed i.e. as soon as tendons and nerves have been located and freed and the surgeon has outlined his plan of repair the cuff is deflated and gauze pressure is maintained on the wound for several minutes. As soon as the cuff is released a marked active hyperemia occurs and gauze pressure must be kept up until this begins to subside, at which time the gauze is removed and bleeding vessels are grasped and ligated. After all active bleeding has been controlled the pressure cuff may be reinflated and the repair completed in a bloodless field. Since the dissection has been accomplished no more vessels are divided. There oozing cannot be controlled completely by ligation and in order to prevent this

oozing after closure of the wound, the blood pressure cuff should not be released until the pressure dressing has been applied. The closed wound is covered with a large amount of stuffed gauze and occasionally a sea sponge, which is bandaged snugly. The surgeon then elevates the arm and adds further pressure with his hands and the cuff is deflated and removed. The manual pressure and elevation are maintained for a few minutes, corresponding approximately to the time of active hyperemia and the finger tips are watched to see that circulation returns promptly. When the patient is returned to his room the arm and hand are kept elevated on a pillow. In one instance following extensive dissection of an arteriovenous tumor the hand was suspended from an overhead frame to discourage venous congestion.

There is a temptation to wrap the blood pressure cuff too snugly about the arm and compress the superficial veins so that they cannot be emptied by elevation. If this congestion occurs, the operative field will be flooded continually by venous oozing even though arterial inflow is prevented. Should this complication occur the cuff must be removed entirely and reapplied since we are only wasting time by going on with the operation.

The manner of grasping and ligating bleeding vessels is an important detail. The hemostat should be small, so that they grasp only the bleeding point and not large amounts of surrounding tissues (Fig. 5). All tissue distal to the ligature becomes necrotic and must be absorbed, and if such necrotic points are multiplied many times during an operation a large amount of non-viable tissue is left in the wound. If a considerable length of vessel extends beyond the point of ligation, the excess should be removed since it also is non-viable. Ligation should be done with very fine silk and the ligature ends cut right on the knot, so as to leave a minimal amount of foreign material in the wound.

During the operation serum, blood, cellular debris, and foreign matter from the atmosphere collect within the wound. The operating room lights, even though of the so called cold variety shine down on delicate exposed tissues and the moisture from the tissues is removed by the circulating air. All of these factors, debris, heat, and drying especially during an operation lasting for several hours, are of importance and should be minimized as far as possible. They may be controlled largely by frequent irrigation of the wound with normal saline solution. The sponges used during the operation should be wrung out in salt solution, and exposed nerves and tendons

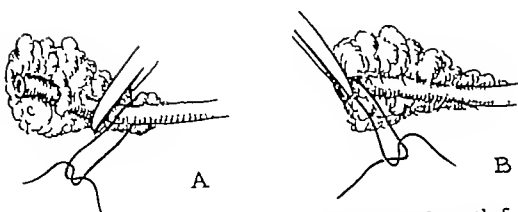


Fig 5 Vessels to be ligated should be caught with fine forceps close to the tip as in B, ligated close to the end and the ligature cut short. In A the forceps have caught the vessel and surrounding tissues, all of which distal to the ligature are destined to become necrotic.

should be kept covered with moist sponges since they are very sensitive to heat and drying.

Closure of the wound so as to ensure prompt primary healing demands accurate apposition of the skin under a minimum of tension. It demands also a minimum of trauma to the skin edges by tissue forceps, retractors, heavy sutures, and large needles. The subcutaneous tissues should be brought together with fine silk so as to provide a soft, non-adherent bed and also to take some of the tension from the skin sutures. The skin sutures should be fine, I prefer fine to medium horse hair on fine curved cutting needles, placing first a series of interrupted sutures at 1 inch intervals and then a running suture taking bites at intervals of about $\frac{1}{8}$ inch. It should not be necessary to exert much traction to secure accurate edge-to-edge closure.

The skin suture line should be covered with a few thicknesses of moist gauze to absorb any serum which may ooze from the wound. If the edges of a crease are allowed to come into apposition at places where the skin is folded on itself, such as occurs at the wrist or at the proximal flexion creases of the fingers, a sort of intertrigo occurs, superficial necrosis may develop, and infection take place. This complication may be prevented if the edge of a small gauze sponge is pressed into the crease so as to keep it separated (Fig 6). Similarly the fingers should be kept slightly separated by gauze if they are to be completely covered by the dressings.

The postoperative care of the wound cannot be simply a routine, for upon this may depend the outcome of the operation. A tiny seam of skin necrosis may heal if properly cared for, but if neglected may ruin a most extensive repair. A thin skin flap may survive if pressure is correctly maintained upon it, if this is neglected, the flap may become necrotic. In such cases the flap is dressed as a free skin graft with sea-sponge pressure which is left undisturbed from 5 to 8 days. It is seldom necessary to examine the wound

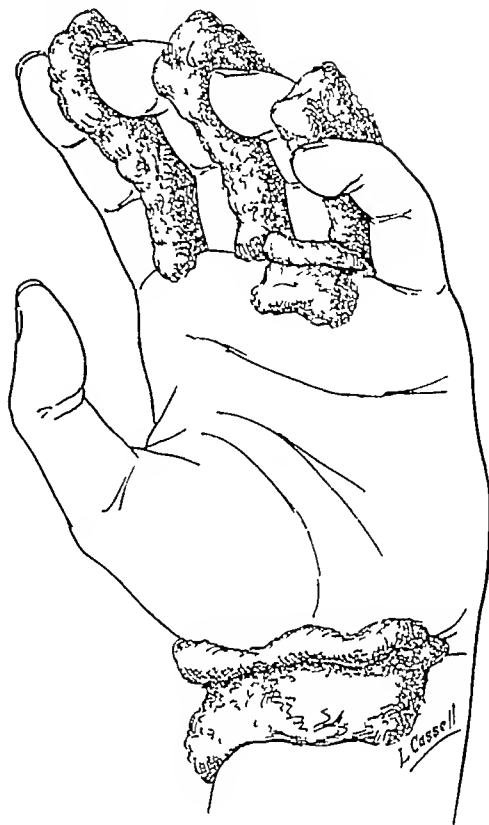


Fig 6 Dressings pressed into skin creases at the wrist and bases of the fingers, and sponges between the fingers prevent maceration.

until it is time to remove the sutures. However, I occasionally look under the dressings on the fifth postoperative day if there is reason to suspect that there has been a subcutaneous collection of serum, that an area of skin necrosis is present, or that some of the skin sutures are too tight. If a subcutaneous collection of serum has occurred, it may be possible to release it and by application of pressure prevent its reaccumulation. If a small area of skin necrosis is present it may be cleansed, the cuticle if loosened over it may be removed, a moist gauze sponge laid over it to favor drainage, and the pressure reapplied. By keeping the area clean and maintaining pressure to favor the return of circulation, the necrosis may be prevented from extending. Skin sutures in the palm are best left undisturbed for 12 to 14 days since healing of the thick palmar skin is quite slow. It is my usual practice to cut the continuous suture in a number of places about the tenth postoperative day, remove it about the

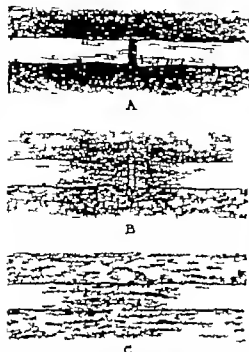


Fig. 7. Diagrammatic representation of manner of healing of tendon. A, First week proliferation of peritendinous and intratendinous connective tissues. B, Second week tendon cell proliferation and obliteration of gap. C, Third to fourth week consolidation of gap tissues and beginning stages in adaptation of surrounding tissues to achieve gliding function.

twelfth day and remove the interrupted sutures on the fourteenth day. But there is no routine about it. If at any time a suture seems too tight it is cut although it is not necessarily removed.

Such in brief are some of the general principles of operative technique applicable to all types of surgery, but a *sine qua non* for successful tendon repair. There are, however, certain peculiarities of tendon which must be taken into consideration. Its long parallel bundles of collagenous fibers have tremendous strength but fray and separate if the tendon is pinched or squeezed and ordinary sutures pull out easily. The blood supply of the tendon is relatively scanty; its longitudinal vessels are scarcely enough to care for its ordinary needs, and they tend to diminish with advancing age. Vessels entering by way of mesotenon or paratenon may be very plentiful in such places as the wrist or dorsum of the hand but are quite scanty in such places as the volar surface of the fingers. The sutured tendon is always under some tonic pull from the muscle above so that even when immobilized on a splint absolute quiet can

not be obtained, nor can we be certain that even if we could secure absolute quiet it would be advisable to suppress muscle tonicity entirely following tendon repair.

The manner in which tendon heals gives us some clue to the principles of repair (Fig. 7). When divided tendon ends have been united by suture reparative processes start within the first 24 hours. They begin in the intra- and peritendinous connective tissues which proliferate across the site of union and into the gap between united tendon stumps. Not until the fourth or fifth day is there evidence of actual increase in the number of tendon cells; the union which exists at this time and the effective union for the first 10 to 14 days is provided for by the thickened and proliferated connective tissue elements. By the end of the second week the gap is bridged by proliferated tendon and from then on the surrounding tissues tend to revert to their original function of serving as a gliding mechanism. During the early stages of repair the tendon must become attached to the surrounding tissues. If these early vascular attachments are derived from dense fibrous or bony tissue firm adhesions are almost certain to form and the tendon becomes frozen in its course. If the attachments are derived from fatty or areolar tissue, they tend to loosen slowly and eventually permit free motion. Tendons surrounded by synovial sheaths receive blood supply through the mesotenons and are partly or entirely surrounded by dense bony and fibrous tissue or osteofibrous tunnels. The flexor tendons in the fingers represent this type and, as is well known, offer the poorest prognosis of

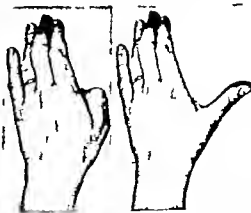


Fig. 8. Division of extensor pollicis longus near base of proximal phalanx. Patient first seen 3 days after injury. Too late to suture. Thumb splinted in extension for 5 weeks with complete healing and functional return.

all the tendons on the hand following repair. The other group of tendons are those surrounded by paratenon, i.e., by lax, areolar tissue from which fibers and blood vessels run directly into the tendon. The extensor tendons on the dorsum of the fingers and distal half of the metacarpus belong to this group. The paratenon covered tendons are well supplied with blood, run through areolar tissue which limits retraction, and present an excellent prognosis after repair. In fact it has been our observation that the dorsal tendons often heal spontaneously if properly splinted (Fig 8).

The sheath covered tendons on both the volar and dorsal surfaces of the wrist have good mesotendons, with the possible exception of the extensor pollicis longus, and with the exception of their short course through the carpal tunnel are surrounded on all sides by loose areolar tissue. Such tendons heal well after proper repair and with a minimum of adhesions. Within the carpal tunnel itself the flexor tendons are confined within a narrow osteofibrous channel and dense adhesions are likely to occur unless some measures are taken to insure that at least along part

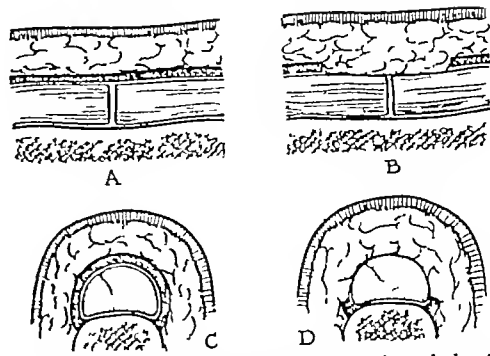


Fig 9 Excision of window in fibrous digital sheath to provide subcutaneous fatty bed for healing tendon. A, Longitudinal, and C, cross sections of finger before excision show line of suture entirely surrounded by osteofibrous tissue to which the healing tendon becomes firmly united. B and D, Corresponding sections following excision of fibrous sheath. The healing tendon, over three fourths of its circumference is in contact with fatty areolar tissue.

of the circumference of the tendons there is fatty or areolar tissues.

The flexor tendons on the volar surfaces of the fingers present a difficult problem of repair. There

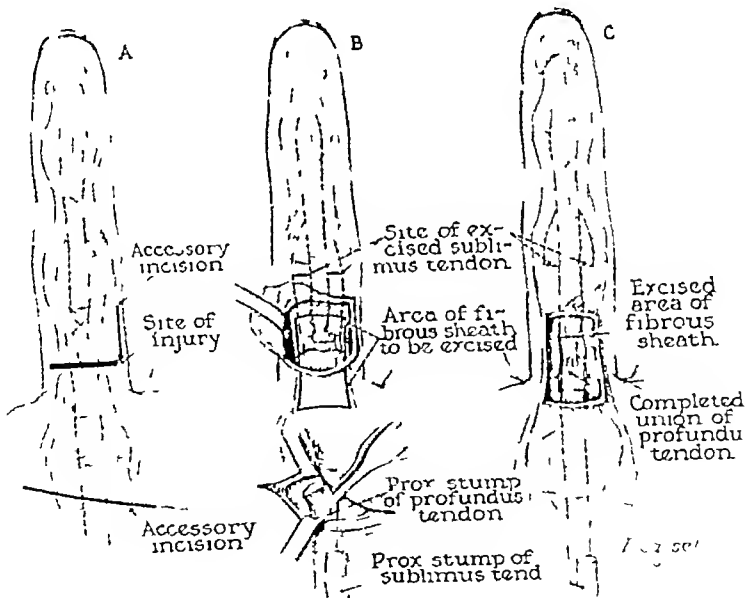


Fig 10 Method of repair of flexor tendons when divided in the digital sheath. A, Short accessory incisions permit exposure of divided tendon in finger and palm. B, The proximal stump of the sublimis tendon is shortened and allowed to retract, or is fastened by side to side suture to the profundus tendon. The distal stump of the sublimis tendon is excised well distal to proposed line of tendon suture. C, After suture of the flexor digitorum profundus tendon, a window about $\frac{1}{2}$ inch long is excised from the fibrous sheath over the site of repair. When the skin is closed the fatty subcutaneous tissues close over the area of suture.

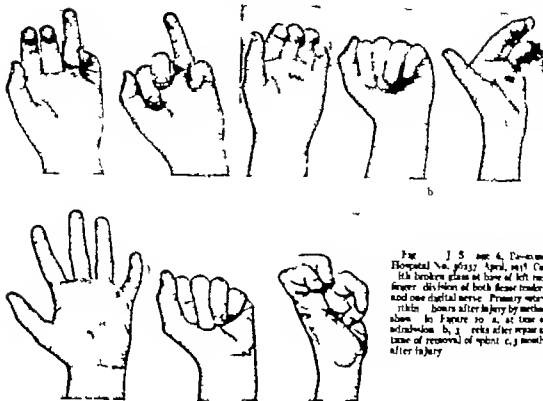


Fig. 10. J. S. Case 4, Post-operative Hospital No. 5537 April, 1915. Cut with broken glass at base of left ring finger division of both flexor tendons and one digital nerve. Primary suture within 4 hours after injury by method shown. In Figure 10 a, at time of admission. b, 3 weeks after repair at time of removal of splint. c, 3 months after injury.

re in reality 3 tendons, the profundus and the slips of the sublimis, tightly enclosed in a dense canal. On the deep surface of the tendons are the periosteum of the phalanges and the dense capsules of the interphalangeal joints, while on the lateral and volar surfaces of the tendons is the tough fibrous tendon sheath (Fig. 9). The sheath is just large enough for its contents and provides scarcely enough space for the repair of one tendon. The line of tendon suture becomes adherent to the walls of the tunnel and function is greatly reduced if not entirely obliterated. All surgeons are agreed that the profundus only should be repaired and the frequently meager success of primary suture has led many surgeons to advise against it and to advocate secondary repair by a graft in all cases. It has seemed to me that repair should be possible if we could insure a fatty bed for the healing tendon and in several recent cases of primary repair the following procedure was carried out (Fig. 10). The sublimis stumps were excised distally and proximally and the profundus sutured in the usual manner. The fibrous sheath was then excised over the area of repair for a dis-

tance of about 1 inch above and below the suture line so that when the wound was closed the united tendon lay directly against fatty subcutaneous tissue. In the few instances of immediate repair in which this procedure has been carried out successful result has been obtained (Fig. 11).

There are numerous methods of tendon suture and each is enthusiastically recommended by its proponent. We have tried a number of methods, choosing those which have seemed to meet the requirements of ideal suture namely that it has a firm anchorage in the tendon, produces a minimum of disruption, does not burden the tissues with a great amount of suture material, leaves the opposed tendon ends free of suture material and lastly does not leave knots between the stumps. During the past year we have been using a method of suture which Dr. Harvey S. Allen and myself have tested out experimentally (Fig. 12). It meets the requirements here enumerated and has proved satisfactory both experimentally and clinically. No. 6 or 8 twisted silk (tensile strength 4½ to 6 pounds) is used on straight

arterial needles. A small bundle of peripheral tendon fibers is caught about 1 centimeter above the tendon end and the suture is knotted about it. The suture is then passed straight through the tendon to come out on the opposite side at a level about $\frac{1}{2}$ millimeter higher than the level of the knot. A second length of suture material is tied about a small bundle of peripheral tendon fibers just below the point of emergence of the first suture, and is then passed through the tendon so as to come out on the opposite side directly above the knot of the first suture. The long ends left at the knot on either side are then cut short and the other ends given a slight pull so as to be sure they are firm. Similar sutures are placed in the opposite stump and the tendons approximated by tying the corresponding sutures. After the tension sutures have been tied the tendon ends may be accurately apposed by a few sutures of No. 0000000 nerve silk. The mechanism of attachment of this suture is quite simple, each half of the suture pulls straight across the tendon and is prevented from slipping by the knot of the other suture over which it rides. The line of pull is thus transferred from a longitudinal to a transverse direction so as to run at right angles to the tendon instead of parallel to its fibers. It does not encircle or constrict the tendon, but simply produces an indentation at one point on either side. The blood supply of the halves of the tendon lying to either side of the transverse course of the suture is not disturbed. The opposed ends are free of suture and there is no foreign material between them.

When confronted with a recent tendon injury, the surgeon must decide whether or not to perform primary repair. There is no question as to the more favorable prognosis of primary repair of divided tendons. There is also no question as to the poor prognosis of secondary repair following failure of a primary one. If the surgeon, therefore, is not reasonably certain that primary repair can be accomplished, it is much better judgment simply to close the wound and plan on secondary repair in a clean wound. The decision to perform primary suture must be made on a consideration of several factors. It is usually unwise to attempt primary repair of tendons if the wound is over 3 or 4 hours old when first seen. In case of flexor tendons on the fingers probably not over 2 hours should have elapsed. If this limit has been passed and if the limit of 6 or 8 hours has not been passed, the wound may be cleansed and closed but the tendons should not be sutured.

The possible sources of wound contamination should be taken into account. We fear especially

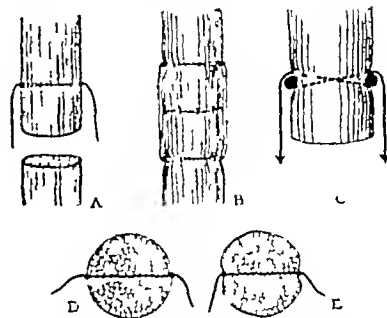


Fig. 12. Method of tendon suture in which the longitudinal pull of the sutures is converted into a transverse pull across the center of the tendon.

contamination with bacteria from human sources, and if we have reason to believe that such organisms have gained entrance into the wound it is unwise to undertake tendon suture. Curiously enough human acclimatized bacteria seldom gain entrance at the time of injury; the usual open wound seldom harbors them. The human bite wound, injuries with postmortem or operating room scalpels, and pins used on septic cases are the only such wounds at all commonly encountered. However, such bacteria may gain entrance as secondary invaders after the injury and every effort should be made to search out such possible sources. Careless first aid treatment, emergency dressings with soiled linen, handkerchiefs, and towels, careless probing with fingers or unsterile instruments, hasty ligation of bleeding vessels under questionable asepsis, and droplet contamination must be considered. It is unwise to attempt primary repair if incomplete surgery has been done elsewhere even though the patient is seen well within the time limit. One unfortunate experience has forced me to defer tendon repair if an antiseptic has been poured into the wound at the time of first aid. Lastly, the surgeon should have at his disposal the assistance and equipment to carry out the operation. To attempt delicate tendon repair with the large forceps and sutures which form the only equipment of many operating rooms is not only useless but may rob the patient of the only chance of obtaining a functioning result.

However, if the various conditions briefly outlined can be met, primary repair of divided tendons is indicated. It is my conviction that almost any wound may be carefully cleansed and rendered surgically clean provided it is seen early and is not contaminated with human acclimated bacteria. I do not desire, at this time, to discuss the general principles of the management of open

wounds, which has been the subject of several recent papers by Reid, Koch and others. Primary tendon suture is postulated on initial care such as these men have outlined. It must be understood of course that in some cases the removal of devitalized tissue, the need for obtaining skin covering, or other complications of the open injury may preclude primary tendon repair. However, in the absence of such complications and if the other prerequisites are present, primary tendon suture may be safely undertaken.

The propitious time to perform secondary repair will depend mainly upon a factor—the condition of the tissues of the hand and the manner of healing which followed repair of the original injury. If the wound was closed and if it healed by primary intention, tendon suture may be safely undertaken 3 to 4 weeks later. If however there was a mild inflammatory reaction or a simple atrophycoccal infection, we should wait 6 to 8 months after the infection has subsided and the wound has completely healed. If a severe spreading infection was present, particularly if streptococcal in nature, an interval of 3 to 8 months should elapse between the cessation of the reaction and the time of secondary repair. There are no infallible tests to indicate whether or not the tissues are free of bacteria, and it is only by experience that we have arrived at these time intervals. In a few cases some lesser procedure such as division of the collateral ligaments of the metacarpophalangeal joints has been done as the first step in repair and this has served as test of operability.

The conditions of the tissues must also affect the decision as to time of secondary suture. We must certainly wait until the induration has subsided and the skin and subcutaneous tissues are free and soft. The joints moved by the severed tendons should be freely movable since it is useless to repair tendons if the fingers are stiff. It not infrequently happens that several weeks or even months of physical therapy may be required to get the tissues into a proper condition

to permit operation. In some instances it may be necessary to mobilize joints operatively particularly the metacarpophalangeal joints in which case division of the collateral ligaments is often successful. In some instances dense adherent scars must be excised and pedicled flaps placed over the area so that subsequent tendon repair may be accomplished through loose fatty tissue. Secondary tendon repair often requires considerable amount of planning, and the surgeon who undertakes it should try to visualize the various procedures and their probable sequence. He should, however, realize that he is not dealing with stereotyped procedures, that he should be ready to meet conditions as they present themselves at the operating table, and he will often be required to make his final decisions as to procedures only after the dissection has been completed.

SUMMARY

Successful tendon repair on the hand, whether it be primary or secondary, will depend upon attention to many apparently trivial details. The surgeon should strive as hard to master as atraumatic technique as he does to ensure asepsis. The atraumatic technique must be followed from the time the skin is prepared for operation until the patient is finally discharged from care. During operation the greatest pains should be taken to prevent tissue injury either mechanical or chemical to ensure hemostasis, and to avoid tissue devitalization. Special attention should be given to details of dressing the wound and to postoperative care. Tendon suture itself is based upon a knowledge of the manner of tendon healing and the method of suture has been described. Primary repair is always advisable if the surgeon can secure the wound early enough, and can assure himself that contaminants from human sources have not entered the wound. Secondary repair may be undertaken when the surgeon is confident that the wound is free of bacterial contaminants and the tissues of the hand have regained normal consistency.

RECONSTRUCTIONS IN NON-UNITED FEMORAL NECK FRACTURES

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NON-UNION of intracapsular fractures of the femoral neck still occurs. A good many of such patients get along quite well with painless fibrous union—one good authority rated such cases in his clinic as 75 per cent—but the remainder do not function at all or function with crippling pain. These non-unions present problems for solution. There are also patients who have union but who are invalid cripples because of pain on weight-bearing or even at rest. This pain is due to a complicating arthritis or to a process of disintegration taking place in the femoral head following internal fixation by nailing or by other forms of metal fixation.

It is obvious that some type of constructive or destructive operation is necessary to give these patients painless and functioning hips. It is evident, however, that because of local or general contra-indications some of these unfortunates cannot be operated upon and must finish their lives as best they can, with crutches, ambulatory splints, pelvic belts, or even wheel-chairs, or in bed. The fair and good surgical risks can be given relief and a varying degree of restoration of function by some type of reconstructive hip operation.

From our personal limited experience with hip reconstruction we believe that there is no universal method. We agree with Brackett, one of the great pioneers in this field, who stated in a recent discussion on this topic in referring to the operating surgeon, that "The important factor is his choice of procedure." To select as best we can, we have learned that we should and must have detailed and intimate experience with and knowledge about the various accepted methods of hip reconstruction before we attempt to do any work in this field.

When we analyze present day methods we find that, in the main, they are surgically old and tried, with some excellent modifications and, naturally, designated with new names. The original Whitman, Brackett, Lorenz bifurcation operation and even the hole-drilling principle in the treatment of non-united fractures first promulgated by Daniel Brainerd in the fifties of the past century, are the

forerunners of the modifications by Colonna, Magnuson, McMurray, Shantz, and Bozsán's hole-drilling operation in non-united hip joint fractures. We have found these latter procedures, which we shall endeavor to evaluate from various angles, plus the hip fusion operation to be sound.

The Colonna type of reconstruction. This consists in (1) the sectioning close to their insertions of all the muscles attached to the region of the greater trochanter with preservation of a thin fibromuscular tissue over the upper end of the bone, (2) the removal of the head, (3) the placing of the upper extremity of the femur deeply and firmly within the acetabulum and the transplanting of the gluteus medius and minimus group of muscles downward on the shaft of the femur as far as they will reach, and the secure fastening of them to the bone, (4) after wound repair and dressing, the application of a plaster-of-Paris spica with the leg in about 20 to 30 degrees of abduction, (5) at the end of 4 weeks the cutting away of the lower posterior half of the cast in the affected leg so as to allow knee flexion several times a day, (6) the removal of the entire cast in the sixth week and the placing of the leg in a special type of foot sling hitched to a Balkan frame and the institution of a special series of exercises, and (7) the use of crutches at the eighth week and direct weight bearing 1 to 2 weeks or more later, depending on the individual case.

The Magnuson method (modification of the Brackett method). We believe with Magnuson that this method combines the best features of the Brackett and Whitman operations. The essentials of this procedure are (1) The exposure by the Smith-Petersen approach, recently we have adopted the Callahan approach, (2) the removal of fibrous tissues between the fractured ends and then a test made to ascertain whether the head is viable or non-viable, (3) the hollowing of the head in the form of a cone, pointing upward and slightly backward, (4) the rotation of the femur inward, and with a thin-bladed chisel the removal of the trochanter in a line sloping from the base of the neck of the shaft, (5) the rounding of the end of the shaft in the same curve as that in which the head has been hollowed out, (6) the abduction of the leg so that the upper end of the shaft may be

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pried into the head (7) the reattachment of the trochanter to the shaft on the cut surface so that it is moved downward and outward and held in that position by heavy silk ligature (8) the application of a plaster-of Paris spica which is retained for 8 to 12 weeks, and occasionally longer as we have experienced (9) the removal of spica, but the legs are kept in some abduction (10) finally, periodic clinical examinations and check-up roentgenograms to determine when actual direct weight bearing can be started.

The various direct bone grafting pegging and hole-drilling methods These we believe need not be described since they are so varied. Suffice it to say that when we decide to use such a procedure we combine them—the direct inlay graft together with bone chips, as well as hole-drilling. Such operations are followed by the use of plaster-of-Paris spica fixations for 6 to 14 weeks and then the use of crutches and protective ambulatory splints until definite firm union has been established.

The McIlwray osteotomy This is a bifurcation operation based on the suggestion of Lorenz in which the shaft of the femur is transferred directly under the lower margin of the acetabulum and head of the femur. The chief purpose of this operation is to change a shearing force into a direct one. The following are the steps in this operation: (1) A 6 inch incision is made along the lateral side of the upper end of the femur in the trochanteric area. (2) The fracture site is exposed so as to place the osteotomy line accurately. (3) An oblique osteotomy is performed beginning on the outer side of the shaft, generally about the lower end of the greater trochanter and ending above the tip of the lesser trochanter. (4) The upper end of the shaft of the femur is pried and shoved inward until the cut end is under the acetabulum and femoral head. This is followed by repair of the wound. (5) A plaster-of Paris fixation is used for a period long enough to ensure union at the site of the osteotomy. This fixation of the limb is in the neutral position in very slight abduction in order to prevent the development of knock-knee following removal of the plaster cast. Fixation is maintained generally $3\frac{1}{4}$ to 4 months. The knee is kept in slight flexion so that the degree of rigidity is decreased.

The hip fusion method This we have done generally by means of Hibbs' method or with some modification when the head had to be removed or was useless. In these cases our former chief, Dr. Cotton, combined Hibbs' fusion operation with Albee's old plan of squaring. Following the fusion, a plaster-of Paris spica is applied and re-

tained until fusion is established. As a rule, this takes 3 to 6 weeks. Then a walking spica is applied. If fusion is quite firm a protective ambulatory splint and crutches, or simply crutches are used. No direct weight bearing is permitted until union has been firmly established clinically and roentgenographically.

These then are the reconstructive operations for non-union of femoral neck fractures which we have used in the course of the past decade, and the following is an evaluation of each method based on our own experiences.

The Colonna method (10 cases) The patient must be a good operative risk for this procedure. The chronological age need not be a deterring factor. The patient must, in the surgeon's judgment, be able to withstand a good amount of surgical trauma. The fracture site should show definite absorption of the femoral neck or head, the less femoral neck remaining, the easier the operation and the better the result. This method can also be considered in cases in which the head of the femur is dead. Arthritic changes in the hip are not conducive to a good result with this type of reconstruction and therefore rule out this operation.

The following is what we have found in 7 successful Colonna cases. The bed and hospital confinement was shorter than by any of the other methods we have used. The average was 6 weeks in bed with another 2 weeks up and about the ward before discharge. Patients left the hospital under their own power with the aid of a crutch or cane depending on their confidence and readjustment ability. The average shortening in these cases was a scant inch. 3 had $\frac{3}{4}$ of an inch, 3 had 1 inch, and 1 had $1\frac{1}{4}$ inches of shortening. We found this shortening to be of no material consequence. It could be corrected with a slightly raised heel. Internal and external rotations at the hip were quite limited. Abduction ranged from 5 to 45 degrees, adduction from 20 to 25 degrees. The flexion at the hip was good and extension normal. Patients could stand alone on either leg. They had painless hips and could walk ordinary distances without fatigue or discomfort though with a slight limp. They had, however, some social and physical discomforts. They complained of inability to put stockings and shoe on the affected leg, and protracted sitting, as at card table, movies, etc., caused a sense of stiffening and discomfort in the affected hip.

To arrive at this result the patient must go through a fair amount of severe surgical trauma, but the period of hip and leg fixation is comparatively short as are bed confinement and hospitalization, which are important items when know-

as in other procedures, what prolonged fixation and bed treatment will do to a patient locally and generally. It is also an important factor from an economical standpoint which today is the concern of both patient and hospital.

The 3 unsuccessful cases were the following

CASE 1. This was a poor choice. Before operation the patient showed some degenerative changes (not absorption) and following operation these changes progressed. However, final fusion set in and today the patient has a stiff and fairly comfortable walking hip. She has to use a cane and can walk quite well.

CASE 2. This case we do not know exactly how to classify. It was a real problem. The patient had a severely painful, non-united femoral neck fracture of the left leg (even on lying down) with an already fused knee joint on the affected leg, and 2 fused elbow joints all due to an old infectious arthritis. After some observation and persistent pleading, on the patient's part, a Colonna operation was decided upon in order to give her at least a somewhat mobile joint with the hope that it would not fuse later. The operation was performed. The hospitalization in this case was very long for a Colonna case—16 weeks. This was due chiefly to the difficulty the patient had in readjusting herself and getting confidence in going about on crutches. However, despite her general arthritic condition she did finally succeed in getting around. The following is a copy of our brief notations in this case in the 1 year follow-up examination.

"Patient still uses crutches. This is because of left knee painful right knee, and hip. She can sit with comfort in chairs but needs help to get up. She prefers sitting on arms of lounging chairs because of comfort and ability to get up under own power. The left hip (the Colonna hip) is painful. It is only occasional soreness in it. Can put weight on left leg without having pain. Rotation limited. Flexion and extension at hip are good, free, and painless through limited range. Patient finds she has to bear most of her weight through the crutches on left leg because of pain in her right knee and hip."

CASE 3. This was an instance of failure due to subluxation of the upper end of the femoral shaft after operation, subsequent attempts at replacement were only fair. Convalescence was protracted, hospitalization lasted 5 months and the patient was on crutches for 9 months. This case is now coming through fairly well and for a curious reason. Check up recently, 18 months after operation the patient could get about with a cane on a painful hip. Nature has fashioned an excellent shelf for the femur.

This case taught us the great importance of snugging the upper end of the femoral shaft into the acetabulum and seeing that it is kept there while wound repair, dressing and spica fixation are going on. We have found that the leg should be kept in at least a 20 to 25 degree abduction spica fixation. It also proved to us the importance of utilizing the capsule in the later wound repair.

The Magnuson operation (5 cases). As previously mentioned this procedure combines the best features of the Whitman and Brackett operations. It should not be considered in cases complicated by arthritic changes or by any suspicion

of cartilage degeneration, irregularity, or in cases in which the head of the femur is dead. We are also of the opinion that non-united fractures of over 1 year's duration, or having no femoral neck left are also poor risks for this operation. From our 3 successful cases by this method we collected the following data.

The method required a very careful selection of cases. It involved somewhat more surgical trauma than the Colonna method. The fixation of the hip and leg and the bed confinement were quite long—10 to 16 weeks. The patient left the hospital from the end of the tenth or twelfth to the eighteenth week. He left under his own power using crutches or an ambulatory Thomas splint and cane. He was bearing direct weight on the affected hip from the sixth to the ninth month. At that time the patient had a solid union of the reconstructed neck and head. He had a hip joint that was 90 per cent and more normal, it was as nearly normal as one could expect from a reconstruction.

The 2 poor results were and are unfortunate. Neither fracture united. There was absorption at the reconstructed site soon following the operation. Both patients were over 60 years of age, chronologically and physically. The non-united fractures were of 12 and 16 months' duration. One of these patients has since died and the other is up and about as a crutch invalid but has a painless hip.

These were the cases which caused us, when considering the Magnuson method, to avoid non-united fractures of over 12 months' duration and in elderly people. Two of our successful cases were also benefited by these failures in that we not only chose them more carefully but in addition to the reconstruction we did the Bozsán's hole drilling and crammed in some bone chips at the reconstruction site.

Bone grafting and allied methods (3 cases). The selection of non-united hip fracture cases for bone grafting, bone chips, and hole drilling, we believe, must be made early and with due care to the general condition of the patients. They must be above average physically in order to withstand successfully the prolonged spica and bed confinement. The femoral heads should be in good condition and some of the neck should remain. Here again, those patients with arthritic changes or tendencies, or with any joint irregularity, should not be selected for these procedures.

Our comments on our 3 successful cases are as follows.

The non-united fractures were of 6 1/2 to 8 months duration. The femoral heads were all in good condition and a fair amount of femoral neck

remained. On one we did a simple, thorough cleaning out of the fibrous tissue between the head and neck, and crammed the resulting gap with bone chips. The 2 others had not only the hole-drilling as advocated by Bozeman, but also inlay grafts and bone chips. In these cases spica fixation was maintained from 12 to 16 weeks and hospitalization lasted 14 to 18 weeks. All these patients left the hospital wearing protective ambulatory splints and using either one crutch or a cane. Direct weight bearing averaged from 6 to 8 months. The knee joints in the affected leg in 3 of these patients lengthened the convalescence and delayed return to normalcy. The third patient had limited knee motion at operation and this limitation persisted. The hips in 3 patients had practically normal range of function which was better than in the successful Magnuson cases.

The simplicity, ease, and non-shocking quality of these allied methods impressed us markedly and made us aware that early recognition of non-union and early decision as regards stimulating therapy should and must be sought.

The osteotomy procedure (2 cases) As in the preceding methods, arthritis and other degenerative joint changes rule out this operation. We have not much to say here since it is only during the past year that we have used this method in our non-union hip therapy. We followed the McMur ray technique. This method was chosen for only 2 patients because they were deemed poor risks for the prolonged and severe surgery of other methods. We can say that the simplicity of the osteotomy etc. appeals to us. Moreover if, as McMur ray, Schantz, and Schumm report, the successful end-results, which are of a goodly percentage, give a high degree of painless hip function which is nearly normal in many cases, this method may supplant those requiring more severe and destructive surgery to accomplish their ends. We cannot give an opinion on this for we have practically no experience with the method. The only 2 patients we had died sometime following the operations. The one feature we do not like about this procedure is that the period of fixation and hospitalization is too prolonged for such poor surgical risks although they do possess a good chance to survive the operative procedure itself.

The hip fusion operation (3 cases) To date we have used this fusion method in only three non-united cases in which definite arthritic or other joint changes are shown. Again, our experience is limited but it has been most satisfactory. Successful end results were obtained in 2 and in a third patient successful outcome followed a secondary stimulation.

Of course, the successful end-result is a well hip with the social and physical discomforts very similar to those after a good Colonna end-result. At least, that is how we have viewed it. To attain this result, however, the patient does have to go through severe surgery, a protracted spica fixation and hospitalization, varying in our hands from 12 to 6 weeks. These are serious factors which we must face before selecting such a procedure which is so tempting because the percentage of failures following its use is lower than for any of the other present day methods.

This then is the evaluation of our experience with the reconstruction methods for use in non-united femoral neck fractures. It is true the number of cases is apparently small for almost a decade of work. Unfortunately this is not due to the scarcity of non-united fractures. It is due to the difficult task of selling an operation to such poor cripples, who already have had their share of fixation and hospitalization, and to the selection of the cases. In our whole series we had but 3 deaths. The comparatively low mortality in these cases in which the surgery often is devastating is due probably to the careful pre-operative preparation, the well selected and conducted anesthesia, and to the postoperative care.

The percentage of successful end-results is quite discouraging. We have been tempted to adopt hip fusion as our routine method for it offers the highest percentage of so called good end-results, and also because of the fact that occasionally progressive postoperative changes in a hip operated upon by another method may convert an apparently good end-result into a poor one. As Colonna has stated somewhere, we would be sacrificing the convenience of motion to the greater strength and more practical use of painless weight bearing. A universal stiff hip idea, however does not and should not satisfy us. We must and should keep on endeavoring to select the operation for the individual—the operation which will result in that type of hip function which that particular patient needs. But if there are intra-articular or extra-articular contra-indications for that procedure, we should select the one which will insure a stable, painless hip. It should be stated that there will be times when the surgeon finds, on actual visualization of the hip joint, conditions other than he expected. He must be ready to discard any preconceived plan of procedure and adopt one that is better adapted to the actual local conditions, thus ensuring a better end-result.

The good results we had in our cases make us wish that earlier recognition and immediate appropriate treatment could be made. This is a job for

the pathologist, the surgeon, and the roentgenologist Dr Ferguson, of New York, has done some excellent roentgenographic work in the diagnosis of pre-coxa-plana cases. Why could not someone do the same with non-united hip fracture cases? If early diagnosis of non-union, i e, in the first 4 or 5 months, could be made, we are sure that some immediate, appropriate, stimulating treatment of a simple nature would be all that would be required. It would no doubt give the patient a practical normal hip and would obviate, in the great majority of cases, the need of any type of hip reconstruction as is the case when the hip fracture is allowed to go to frank non-union.

In conclusion I would once more refer to Brackett who said "There is now need of special

study and observation particularly by collection of end-results to aid in the application of the methods which we already have to the various types of cases and to act as a guide in the choice of the method of treatment."

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The good results we had in our cases make us wish that earlier recognition and immediate appropriate treatment could be made. This is a job for

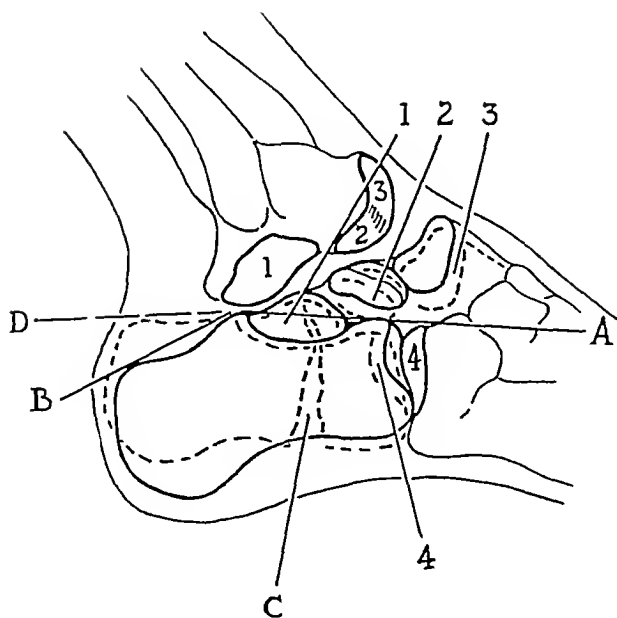


Fig 1

Fig 1 A diagnostic sketch of the subastragalar joint and the midtarsal joints. The unbroken outlines of the facets marked 1, 2, 3, and 4 show the joints opened from the lateral side and plantar flexion of the forefoot. The dotted lines of the misplaced bones and facets following fracture show the change in relation to the facets, which is the chief factor in producing a stiff and painful subastragiloid joint. The basis for this sketch was taken from Conn's article, "Fractures of the Os Calcis," in *The Journal of Bone and Joint Surgery*, April, 1935.

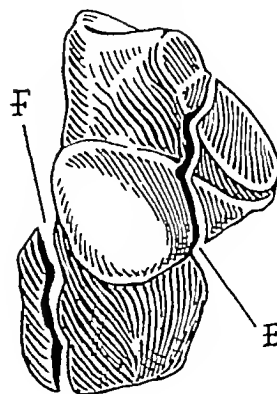


Fig 2

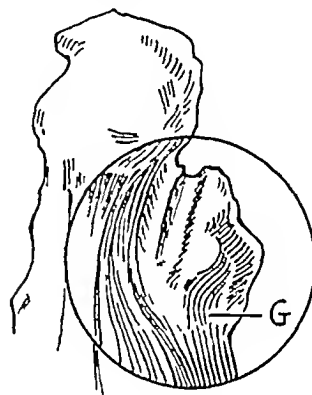


Fig 3

Fig 2 A schematic drawing showing 2 common types of longitudinal fracture. The fracture marked E is a separation of the sustentaculum tali with rotation of the main portion of the os calcis. It is this rotation and separation which destroys the normal relation of the articulating facets and produces pain and reduced function of the subastragalar joint. The fracture marked F demonstrates a

longitudinal fracture of the tuberosity not entering the joint, and is a frequent cause of bone pressure with accompanying pain below the lateral malleolus.

Fig 3 The under surface of the sustentaculum tali. The calcaneosaphoid ligament marked G when disrupted from its normal course as a result of fractures of the sustentaculum is a frequent cause of pain in the midtarsal joint

tuberosity, as a rule are the more simple types to deal with. They may be split fractures, where the fracture line extends longitudinally through the bone from the back forward, or they may pass directly across the bony mass. They may become impacted and shortened in the long axis, spoken of as being telescoped, and they may be comminuted. They always affect the contour by destroying the so called tuber-joint angle, as described by Boehler, and they may spread as the result of a split and give a broadened appearance to the heel.

The treatment of this type of fracture consists of restoring the tuber angle by traction. The results from such reductions are usually quite satisfactory. The lateral masses are replaced by lateral compression, the spring action of the foot

is regained, and so the normal line of weight bearing is restored.

The greater problem is found in the type of fractures entering the subastragalar joint whether of the split or the crush variety, practically all are comminuted. These are difficult to diagnose and to reduce accurately, and have a high percentage of disability as well.

Most writers regard the fractures of the sustentaculum tali as being a distinct type, but when the anatomy is considered there is little basis for separating it in its classification from the other split fractures of the body of the os calcis. The anterior facet is largely, though perhaps not wholly, on the superior surface of the sustentaculum, and when this shelf is split off from the main body of the bone, the articular facet is

THE TRACTION TREATMENT OF FRACTURES OF THE OS CALCIS

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THE value of traction treatment unquestionably means whether a satisfactory reduction may be accomplished, whether it is a better method of reduction than a purely manipulative one, and also, whether the results are more satisfactory than when an arthrodesis is performed.

Many methods of reduction with the use of traction have been devised, some of them very recently but the outstanding method, and the one on which many of the newer suggestions are based, is without doubt that of Lorenz Boehler a description of which was first published approximately 10 years ago. In brief, it consists of breaking up the impaction as thoroughly as possible, and then with a system of fixed traction, drawing the fragments into as nearly a normal position as possible. When this is accomplished, as proved by roentgenograms, the fragments are pressed together laterally to overcome their spread and to accomplish impaction in this replaced position. At first, traction was continued after fixation of this remodeled mass in a plaster cast, but later Boehler discontinued the traction after fixation and allowed all the pins to remain for extra fixation. The after treatment consists of plaster fixation until bony union has taken place, and walking is encouraged as early as possible with the use of a walking iron attached to the plaster. This is termed the walking cast and its main object is to maintain the proper muscle tone and to enhance circulation.

Previous to Boehler's suggestions as to treatment, little had been done since Cotton recommended the breaking up of the impaction and reimpacting the fragments, especially the troublesome mass protruding below the external malleolus which was thought to be the most disabling feature. So anxious were surgeons to find a possible solution for this seriously disabling injury that Boehler's method became popular almost overnight. Boehler's paper gave a very detailed technique for every step in his procedure, and it seemed that at last a way to restore these injured men to their former usefulness was at hand.

The method was widely if not wisely used. Seemingly it was employed without a very clear understanding of the real significance of the problem at hand, and the end-results of the average cases so handled showed very little improvement in the amount of permanent disability.

This condition led to a very considerable amount of real investigation as to why this seemingly accurate method of reduction failed to give the expected and hoped for results, and from this has come a much clearer conception of the injury and many suggestions as to how the problem may be solved.

Boehler in his early papers, formulated a classification of the types of fractures. He classified them according to the portion of the bone affected by the fracture, the deformity resulting from the involvement of certain areas, just how each problem was to be handled, and its possibility of correction.

It was probably because of excessive enthusiasm that the profession did not take in fully the many problems connected with this method and so were not prepared to handle the many pitfalls encountered. Much of this work was unquestionably done without a full realization of its magnitude. As a result, there has been a tendency to develop other methods rather than to determine and correct the weaknesses found in Boehler's procedure. From all this uncertainty much good has come and will continue to come as our statistics of end-results become more accurate and helpful.

In a broad way for the sake of study of the use of traction in reduction, we must classify the fractures lending themselves to such a treatment into a main groups. Those not entering the joints of the os calcis, and those which do enter the joints, more especially which enter the subastragalar joints.

The superior surface of the os calcis contains a distinct facets or articulating surfaces, which have an important bearing on comminuted fractures of the body of the bone, as will be shown later.

Fractures of the posterior portion of the os calcis, that is, that portion of the body posterior to the subastragalar joint, and spoken of as the

TABLE I—ESSENTIAL FEATURES OF RECORD OF FRACTURE OF OS CALCIS

- 1 History and type of injury (fall or explosion) Age and weight.
- 2 Time elapsed between accident and time of reduction
- 3 Types by x ray finding (a) intra articular or extra-articular, (b) comminution, (c) tuber angle depressed, (d) foreshortening
- 4 Exact type of treatment—specify clearly
- 5 Time elapsed before weight bearing following reduction
- 6 What type of apparatus, if any, used after weight bearing has been started
- 7 Time elapsed between injury and return to duty
- 8 Percentage of disability—as rated by Industrial Accident Commission.

dents occur in industry, we hope that the information which we seek will be forthcoming, not in only one state but in all states

It is a generally accepted fact that of all injuries, the fracture of the os calcis is the most disabling one a man in industry can sustain. It might amuse you, as it did me when making inquiries through a state insurance company, to find that no separate records were made of this injury, and that there were no statistics of any kind available.

Much information unquestionably could be obtained which would be of inestimable value in solving our problems if we could induce all of our State Industrial Accident Commissions and the leading insurance companies handling compensation work to co-operate in gathering more accurate records, not only of the exact type of fracture sustained, but of what was done to overcome the malposition of the fragments, and how successfully this procedure of reposition had been accomplished. It could then be determined just how successful surgeons have been in the application of any given recommended type of treatment. I believe every case record should include the points shown in Table I.

The following is a quotation from Reich in regard to this: "In the discussion of the end-results very few of the writers have expressed an opinion as to what their criterion of good results actually is. Since the subastragalar joint has been the determining factor as to disability, the question has always arisen whether or not there is pain in the joint on weight-bearing, and as a corollary the patient has complained of less pain the greater the limitation of motion."

CONCLUSIONS

Traction has proved to be an excellent way of reducing fractures of the tuberosity where the comminution is not too great to allow a proper

grasp of the fragments, so that the tuber-joint angle can be reduced and the spread of the bone can be compressed to normal.

Traction has been of great assistance in reducing fractures of the body of the os calcis entering the subastragalar joint. The amount of success obtained depends upon thoroughness of disimpaction, accuracy of replacement of the fragments before compression with the clamp, followed by sufficient fixation to allow firm bony union.

There is always bound to be some uncertainty as to the result from the closed method of reduction in all cases of fractures of the os calcis when the fracture lines enter the subastragalar or calcaneocuboid joints, or where the ligamentous support of the astragaloscaphoid joint has been disturbed, because of inability to obtain accurate roentgenograms by any means of roentgenography now at hand.

When the Boehler traction method of reduction has been strictly followed, the permanent disability rating has been greatly reduced especially in the less severe fractures of the tuberosity.

It must be understood that to accomplish a good result by the use of traction for reduction in fractures of the os calcis, one must have a thorough knowledge of the pathology and a keen appreciation of the use of the tools at hand. It is not a method to be attempted by the uninitiated and can serve no good purpose in his hands.

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entered by the fracture line, and the relation between the anterior and posterior subastragular joint facet is lost, which immediately makes for joint malalignment with all of the subsequent difficulties.

Since a large part of the body weight is carried on the sustentaculum, when it is loosened the foot is thrown into pronation, which also rotates the body of the os calcis into pronation. This results in bony impingement of the lateral side of the body against the lateral malleolus, and in addition, produces a rotation action at the anterior end of the os calcis at the calcaneocuboid joint with disruption of the function of the calcaneoscaphoid ligament.

The inferior calcaneoscaphoid ligament is always subject to injury in fractures involving the sustentaculum tali and is apt to be so in fractures of the neck or head of the os calcis in which it articulates with the cuboid. Fractures involving these structures must necessarily affect the complicated rotary and lateral movements of the forefoot. It was continued painful movement in these joints, associated with pain in the subastragular joint, which prompted Conn to do his triple arthrodeses.

In doing a reduction by traction, such as Borden recommends in this type of case, there is knowing when an exact reposition of as been accomplished and if the clamp is applied to produce impaction, it's a question of luck if perfect reposition action occur

Conn, who has reported his findings on opening joints for subsequent arthrodeses, states, in a operative exposure has frequently disclosed serious articular disruption, when the roentgenograms were nearly or completely negative for joint involvement. And further we have come to consider any appreciable loss of lateral motion in the subastragular joint, or the presence of thickening and untoward bone on the external surface of the tuberosity of the os calcis, as diagnostic of disruption of all of the reciprocal articulations of the calcaneum, irrespective of the roentgenographic findings. We have visible

by this very conscientious observer of the facts of fractures entering these joints.

When there are several longitudinal splits, especially when the lateral cortex is separated, the bloom of breadth and pressure beneath the eolus becomes increased and the disrupted oneal tendons, which lie in a groove in this late split off from the lateral cortex.

In the care of this type of fracture then it could seem that if these fragments could be per-

fectly replaced and pressed together to produce impaction so that they would hold their proper relation, a satisfactory repair would result.

Theoretically this is correct but there are two stumbling blocks. First, it has been impossible to determine when this perfect reposition has taken place. So far roentgenograms have not given this information satisfactorily. Second, an impaction of fragments inaccurately reduced is fatal to a painless result.

The other type of fracture entering the joint is even more severe and holds out little chance for a reduction and a very poor prognosis should be admitted from the first. In this group undoubtedly the highest disability ratings occur. These are the comminuted crush fractures affecting especially the articulating surfaces of the subastragular joints. If the fracture lines enter the joints or separate the facets, we know that the mechanism of that joint is interfered with, that is, that the different joint surfaces no longer act in unison and should the fracture lines heal with this discrepancy they can never work again with their former smoothness. In most instances these joint surfaces are pressed down into the underlying cancellous bone and become impacted there.

The disimpaction of these fragments becomes a real problem, since there is no way of holding or bringing force to bear on the individual fragments. Cotton attempted to disimpact them by the blows of a hammer on the side of the bone. Yerg seems to have been successful with manual manipulation, but the problem still remains difficult in the hands of the average surgeon.

This difficulty has led to many attempts at open reduction to pry the impacted articulating facets up into their normal position, but these attempts have not received great popularity. Apparently the success of any attempt at a perfect restoration of these badly comminuted fragments into the joints, which means ability to use the foot in a normal way with full function and without pain, is an improbability.

Accepting this as true, what then should be our goal as to a satisfactory result? We may say an ability to walk with as little pain as possible. How can we find a yard stick with which to measure the disability? We should have some generally accepted standard. It may be that the State Industrial Accident Commissioners will supply us with this standard. Then we could determine if what we are doing produces results which come up to the standard and if not, we may investigate and find out where we have failed and develop methods of care which will improve our results. Since the great majority of such acci-

TABLE I — ESSENTIAL FEATURES OF RECORD OF FRACTURE OF OS CALCIS

- 1 History and type of injury (fall or explosion) Age and weight
- 2 Time elapsed between accident and time of reduction
- 3 Types by x ray finding (a) intra articular or extra articular, (b) comminution, (c) tuber angle depressed, (d) foreshortening
- 4 Exact type of treatment—specify clearly
- 5 Time elapsed before weight bearing following reduction
- 6 What type of apparatus, if any, used after weight bearing has been started
- 7 Time elapsed between injury and return to duty
- 8 Percentage of disability—as rated by Industrial Accident Commission

dents occur in industry, we hope that the information which we seek will be forthcoming, not in only one state but in all states

It is a generally accepted fact that of all injuries, the fracture of the os calcis is the most disabling one a man in industry can sustain. It might amuse you, as it did me when making inquiries through a state insurance company, to find that no separate records were made of this injury, and that there were no statistics of any kind available.

Much information unquestionably could be obtained which would be of inestimable value in solving our problems if we could induce all of our State Industrial Accident Commissions and the leading insurance companies handling compensation work to co-operate in gathering more accurate records, not only of the exact type of fracture sustained, but of what was done to overcome the malposition of the fragments, and how successfully this procedure of reposition had been accomplished. It could then be determined just how successful surgeons have been in the application of any given recommended type of treatment. I believe every case record should include the points shown in Table I.

The following is a quotation from Reich in regard to this: "In the discussion of the end-results very few of the writers have expressed an opinion as to what their criterion of good results actually is. Since the subastragalar joint has been the determining factor as to disability, the question has always arisen whether or not there is pain in the joint on weight-bearing, and as a corollary the patient has complained of less pain the greater the limitation of motion."

CONCLUSIONS

Traction has proved to be an excellent way of reducing fractures of the tuberosity where the comminution is not too great to allow a proper

grasp of the fragments, so that the tuber-joint angle can be reduced and the spread of the bone can be compressed to normal.

Traction has been of great assistance in reducing fractures of the body of the os calcis entering the subastragalar joint. The amount of success obtained depends upon thoroughness of disimpaction, accuracy of replacement of the fragments before compression with the clamp, followed by sufficient fixation to allow firm bony union.

There is always bound to be some uncertainty as to the result from the closed method of reduction in all cases of fractures of the os calcis when the fracture lines enter the subastragalar or calcaneocuboid joints, or where the ligamentous support of the astragaloscaphoid joint has been disturbed, because of inability to obtain accurate roentgenograms by any means of roentgenography now at hand.

When the Boehler traction method of reduction has been strictly followed, the permanent disability rating has been greatly reduced especially in the less severe fractures of the tuberosity.

It must be understood that to accomplish a good result by the use of traction for reduction in fractures of the os calcis, one must have a thorough knowledge of the pathology and a keen appreciation of the use of the tools at hand. It is not a method to be attempted by the uninitiated and can serve no good purpose in his hands.

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and condition of the individual, and the position of his body at the time of injury, most extensive skeletal and visceral damage may result with even occasional contrecoup manifestations. In the aged, for example, a relatively slight blow may cause extensive hemorrhage into the soft parts with its resultant dangers of imperfect absorption, infection, and embolism. Sometimes a traumatic pleurisy may result, either dry, which clears in a few days, or with a clear or bloody effusion. There may be an associated, low-grade febrile reaction, which, if due to the traumatic pleurisy alone, should subside within a week or 10 days, otherwise lung involvement or the possibility of latent tuberculosis should be considered. In any event the patient should be kept in bed until the fluid has absorbed and the temperature has been normal for a week. If it appears that there are more than 200 cubic centimeters of fluid present, diagnostic puncture is always indicated. If a clear or slightly blood-tinged fluid is found, it is removed only to relieve pressure symptoms or perhaps to help hasten resorption when this is unduly slow. I do not favor replacing these simple effusions with air because it is not necessary. Furthermore, should tuberculous pleurisy occur, healing must take place by complete adherence of the pleural layers. This is aided by the natural absorption and organization of the fluid and hindered by the establishment and maintenance of a pneumothorax.

A hemothorax or pneumohemothorax, however, presents a different problem. The patient may or may not present evidence of hemorrhage. With only a small amount of blood present, nothing need be done. Otherwise the blood should be aspirated and replaced by two-thirds to three-quarters as much air. This maintains some tamponade at the bleeding point and facilitates healing of a torn lung, at the same time it permits re-expansion of the lung while keeping the pleural surfaces thin and free from the organizing blood clot. Unless the blood is removed a dense fibrothorax may result with extensive fibrosis of the pleura and atelectasis of the lung, possible permanent pockets of residual pneumothorax, and marked retraction of the ribs, mediastinum, and diaphragm. If the hemorrhage has been sufficient to cause symptoms, transfusion may be necessary. Failing a suitable donor, the blood from the pleural cavity may be removed into sodium citrate solution to 0.5 per cent dilution, filtered, and refused into the patient up to 12 hours following its appearance. If hemorrhage persists, it may be necessary to attack the bleeding point directly by open operation. Should this be the

case, it is well to remember that a small, free, muscle graft is often helpful as a hemostatic. If held in place with moderate pressure for 5 minutes, any venous bleeding may be controlled, even bleeding from a moderate sized artery, particularly if the pressure is low, as in the pulmonary bed or after hemorrhage.

A hemothorax should be sought for not only in the injured but in the contralateral side as well—the contrecoup type. This may occur from a sudden wrench, strain, or convulsive effort which tears a vascular adhesion in the opposite pleural cavity.

It is generally recognized that contusions of the chest wall may cause a localized atelectasis of the underlying lung with subsequent bronchitis or pneumonia, or may activate a quiescent tuberculosis. The best prevention against atelectasis and pneumonia is a free and adequate oxygen supply, which is particularly true in the emphysematous or asthmatic individual, sufficient sedation should be employed to allay pain on respiration and thus prevent too much splinting of the injured chest, but yet not enough to depress respiration, a binder or strapping should be applied to effect the same purpose, a change of position with the patient semi-upright most of the time should be instituted, plenty of fluids are to be given to prevent viscosity of bronchial secretions, productive cough, if present, should be encouraged with the aid of benzoin inhalations and expectorants, and finally, direct bronchial aspiration should be performed if the patient is unable to rid himself of his secretions. Great care should be taken to ascertain what, if anything, the patient had in his mouth at the time of injury to guard against the possibility of an otherwise unsuspected foreign body lodging in the tracheobronchial tree. If there is any suspicion of this, repeated roentgenographic studies with the patient in different positions should be made and bronchoscopic examination demanded. A painstaking history with this in mind is of extreme importance.

PLEUROPULMONARY WOUNDS

Pleuropulmonary wounds are of 2 kinds (1) those in which the chest wall is intact, and (2) those involving parietes, pleura, and lung. The common etiology for the first group, aside from the spontaneous injuries already mentioned, is from fractured ribs. Apart from the local tenderness and painful respiration, there may be hemoptysis, crepitus may be present, and there may be subcutaneous emphysema about the site of fracture along with the signs of pneumothorax. When this last happens, a pressure pneumothorax rarely

and may be either unilateral or bilateral. Following the immediate treatment for shock and hemorrhage and the necessary surgical dressing of wounds we must attempt as soon as feasible to restore the mechanics of the cardiorespiratory system to their normal state and then maintain an approximation to this as close as possible. This requires a frequent appraisal of the patient's condition by physical signs, roentgenograms, manometric readings of intrapleural pressures, and prompt aspiration or temporary closed drainage to correct any sudden pressure change which might prove fatal if unrecognized or allowed to persist. Immediate major operative intervention should be reserved for wounds of the heart or esophagus, large wounds of the chest wall, hemorrhage from an internal mammary or intercostal vessel, and occasionally for injury of the lung itself in which a large vessel is torn and is not controlled by the ensuing pneumothorax. Immediate operative procedures may be rarely necessary for diaphragmatic rupture with acute ileus of the displaced intestine.

The usual types of chest trauma encountered are contusions and crushing injuries caused by blows, falls, and automobiles, and penetrating gunshot and stab wounds. These last are frequently made by ice-picks, which, together with bullet wounds, leave a chest wall almost intact and unless a bit of clothing or other foreign matter is carried into these wounds they usually heal without infection.

MEDICAL, SPONTANEOUS, OR INTERNAL TRAUMA

A fairly large and interesting group of accidents occur quite spontaneously during fits of crying in infants, paroxysms of coughing or sneezing, sudden straining or wrenching movements with increased intrapulmonary pressure, or occasionally without apparent cause. The presence of disease—tuberculosis and bullous emphysema—greatly increases the possibility of such trauma. The injury may appear as fractures of one or more ribs due to coughing, as is not uncommonly seen in cases of pulmonary tuberculosis, the fracture usually occurring near the insertions of the serratus magnus muscle. The patient may feel a sharp pain and have local tenderness or be may not be aware that anything has happened except a sense of muscle discomfort or a little "pleurisy" and frequently neglects to mention it. Later the fracture will be seen in routine x ray examination; there may be several fractures in the same patient, some healed and perhaps a more recent one.

Another accident of this sort is rupture of the lung, or spontaneous pneumothorax. Multiple

episodes occur sometimes in patients with bullous emphysema due to the rupture of a bleb. Spontaneous pneumothorax appears also following the rupture of a tuberculous focus, the tearing of a small adhesion, or without any apparent cause. There may be very few symptoms, transitory pain, dyspnea, palpitation, or a flopping sensation in the chest or on the other hand, they may be fulminating with the rapid development of tension pneumothorax or of emphysema if infectious material has escaped. Such a course is usually caused by a valve-like tear in the lung so that air readily enters the pleural cavity through this rent but cannot escape; thus a tension pneumothorax soon develops with high intrapleural pressure, marked dyspnea, cyanosis, rapid pulse, mediastinal displacement to the opposite side, and high venous pressure. This must be relieved promptly and cautiously either by repeated aspirations or closed catheter drainage, otherwise the patient will die. If the tear is on the mediastinal surface of the lung, the adjacent, very thin pleura may also be torn permitting the escape of air into the mediastinum, thence into the neck along the vascular sheaths, and finally out through the cervical fascia into the subcutaneous tissues, from which point it may spread over the body and become so marked as to require relief by incision over the vascular sheath low in the neck. Fortunately this is rarely necessary. It is the picture sometimes seen in infants after hard fits of crying and again in pulmonary tuberculosis with sudden rupture of the lung at its mediastinal attachment. Spontaneous pneumothorax may also be accompanied by an extensive hemothorax from the tearing of a vascular parietal adhesion. Unless the bleeding can be controlled by aspiration and artificial pneumothorax, the hemorrhage should be sought for and controlled in order to save the life of the patient. Finally, we have chemical trauma due to inhalation of smoke or gas with damage to the alveolar epithelium and the intrapulmonary mechanism of gas exchange. Although all of these except the last are usually handled by the internist and rarely encountered by the surgeon, nevertheless they are forms of thoracic trauma just as much as are the commoner varieties about to be discussed.

CONTUSIONS AND ABRASIONS OF CHEST WALL EXCLUSIVE OF THE PERICARDIUM

Contusions and abrasions constitute the simplest form of external trauma and there may be nothing more than slight localized swelling or ecchymosis. On the other hand, depending upon the violence and extent of the blow or fall, the age

and condition of the individual, and the position of his body at the time of injury, most extensive skeletal and visceral damage may result with even occasional contrecoup manifestations. In the aged, for example, a relatively slight blow may cause extensive hemorrhage into the soft parts with its resultant dangers of imperfect absorption, infection, and embolism. Sometimes a traumatic pleurisy may result, either dry, which clears in a few days, or with a clear or bloody effusion. There may be an associated, low-grade febrile reaction, which, if due to the traumatic pleurisy alone, should subside within a week or 10 days, otherwise lung involvement or the possibility of latent tuberculosis should be considered. In any event the patient should be kept in bed until the fluid has absorbed and the temperature has been normal for a week. If it appears that there are more than 200 cubic centimeters of fluid present, diagnostic puncture is always indicated. If a clear or slightly blood-tinged fluid is found, it is removed only to relieve pressure symptoms or perhaps to help hasten resorption when this is unduly slow. I do not favor replacing these simple effusions with air because it is not necessary. Furthermore, should tuberculous pleurisy occur, healing must take place by complete adherence of the pleural layers. This is aided by the natural absorption and organization of the fluid and hindered by the establishment and maintenance of a pneumothorax.

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occurs as a decompression has already been made into the soft tissues, which are capable of absorbing very large amounts of air escaping from the lungs. The site of injury should be immobilized, sedatives given to allay pain, and the pneumothorax and hemothorax carefully watched and relieved if necessary. Pulmonary bleeding is generally controlled by the collapse of the lung.

Puncture wounds such as are made by bullets, ice-picks, and small knives are very similar. Unless clothing or some other foreign body has been carried into the pleura, infection is rather the exception than the rule. The treatment is the same as that already described, namely aspiration of the blood and replacement with air after the patient has recovered from the initial shock. Hemorrhage with injuries of this type, however, is frequent, due to division of the internal mammary or intercostal vessels. This calls for prompt open operation with ligation of the bleeding point if the signs of hemorrhage are present, transfusion is also usually indicated. Mere bleeding from the wound does not demand operation unless it is evident that the source is still active. If, after injury these patients are placed with the opening in the chest wall in a dependent position, it is astonishing how much of the blood from the hemothorax will trickle out through the wound. This has the added advantage of keeping the good lung uppermost, thereby preventing contralateral spill and likewise splinting the injured side. Here again the opposite chest should be examined for possible contrecoup damage.

The most serious and distressing of the chest injuries are those with multiple rib fractures resulting from extensive trauma. In addition to the physical violence itself the patient has suffered a severe psychic shock with the immediate agony of impending death, followed by days of great suffering and sensation of suffocation. The patient is always in shock there may be bilateral pneumothorax with extreme respiratory embarrassment and there may be depression of the sternum with added venous obstruction. First, as with all thoracic trauma, the head of the bed is elevated. Second, the patient is placed in a very high oxygen or oxygen helium atmosphere preferably by use of the B. L. B. apparatus¹ the use of an oxygen tent, or by nasal catheter thus maximum ventilation and oxygenation with minimum effort is maintained and shock is combatted. Third, the pneumothorax and hemothorax must be relieved. Fourth, sedation or nerve block to relieve pain and restlessness, and support for the chest by

sandbags or binder should be provided. Paravertebral nerve block is particularly valuable. When opium is used, frequent small doses are better than occasional large ones for there is less respiratory depression when the drug is so administered. Fifth, transfusion should be given and repeated if indicated. This should be done cautiously the amount should depend upon the response of the patient. This and 100 per cent oxygen inhalation are the best methods we have to combat shock, and, by increasing the oxygen combining power of the blood, to overcome also the acapnia that may be present due to rapid shallow respirations with resultant washing out of the carbon dioxide. Sixth, cardiac or pericardial injury should always be suspected in this type of injury. Seventh, elevation of a depressed manubrium or sternum may be required. At best the mortality is high, the incidence of pneumonia considerable, and the later reconstruction of the survivors is often difficult and discouraging.

OPEN WOUNDS OF THE CHEST WALL AND PLEURA

If there is a large gaping wound in the chest wall and pleura, the opening should be covered or packed immediately with anything at hand. As soon as possible it should be carefully debrided, the wound in the lung, if present, sutured, the lung re-expanded, the pleura and soft parts closed tightly and closed drainage or suction provided up to 10 centimeters of water at the dependent part of the pleural cavity. If there is no evidence of suppuration, this may be discontinued in 3 or 4 days. If the wound is not large and sucking, simple cleansing and suture are required with further operation only to control bleeding. Following this the patient is placed with the wound down for the reasons already mentioned, and 24 to 48 hours later the pleura is aspirated.

RECAPITULATION

1. I cannot emphasize too strongly the necessity of aspirating a hemothorax of over 300 or 350 cubic centimeters. The continued presence and organization of blood in the pleural cavity causes a marked degree of fibrothorax, the late appearance of empyema in the residual thick walled pleural space and atelectasis and bronchiectasis in the underlying compressed lung.

2. Except for aspiration and air replacement in hemothorax, the treatment for wounds of the chest wall, pleura, and lungs is non-operative. Operation should be undertaken only to close large wounds and to control bleeding from the intercostal and internal mammary vessels and

¹ An apparatus designed by Dorothy Lowrance, and Buchanan for the administration of oxygen or oxygen and helium.

only rarely from the lung itself when this cannot be controlled by pneumothorax. With this method of treatment Elkin has reported a mortality of only 6 per cent in a series of 553 cases, including 11 penetrating wounds of the heart.

WOUNDS OF THE PERICARDIUM AND HEART

These are of 2 kinds, the penetrating and the blunt injuries. The former are often quickly fatal from hemorrhage especially when the auricles are penetrated. A certain number, however, particularly wounds of the ventricles, are amenable to treatment and prompt action may mean the difference between life and death. When the patient is seen, there is usually a small wound to the left of the sternum between the third and sixth spaces, or along its right border. The wound may be bleeding freely or there may be merely a persistent trickle, and there is often a history of injury followed by a period of activity and then sudden syncope. There is a gray cyanosis, distended veins of the neck, increased venous pressure, small or absent pulse, dyspnea, increased cardiac dullness, absence of heart sounds, and low or absent blood pressure because of an acute compression of the heart. Diagnosis is made positive by fluoroscope which reveals an absence of cardiac pulsation. In doubtful cases and even in the presence of apparent death up to 15 or 20 minutes immediate operation is indicated. This acute compression is caused by bleeding from the heart into the pericardium with resulting compression or tamponade. Two costal cartilages, the third and fourth, or fourth and fifth, are resected, the ribs spread gently, and the pericardium opened. The blood is evacuated and the wound in the heart sought for and repaired. A transfusion or refusion, or if these are not possible, an infusion, is started and the heart is massaged gently and rhythmically. Even though no movement is at first visible, contractions may begin again if this procedure is continued for some minutes, adrenalin may be injected into the ventricles if contractions do not commence or if their response is weak. Meticulous asepsis, hemostasis, and gentle handling of tissues are essential. The pericardium is closed without drainage or left open into the pleura, and the pleura, if opened, is aspirated and the lung re-expanded. The patient is placed in an oxygen tent, or a B. L. B. apparatus is employed. If these are not available, intranasal oxygen can be administered following operation. A recurring accumulation of fluid in the pericardium or pleural cavity during convalescence must be watched and aspirated as indicated. These injuries are not as fatal as was formerly supposed. Bigger, in a

collected series of 141 cases, including 11 of his own, gives a mortality of 50 per cent. Success lies in early diagnosis and prompt operation, when any doubt exists, operation is usually the more conservative course.

There is a small group of cases, however, described by Bigger and mentioned by Elkin, in which the diagnosis is doubtful and in which conservative therapy should be followed. The author has had 1 such case. The wound is in the precordial area but the patient has recovered from his shock, the heart sounds are audible and may have a tinkling or splashing quality, the venous pressure is low and there are signs of blood in the pleura. This patient probably has a superficial or small penetrating wound of the heart with a wound of the pericardium into the pleura allowing prompt decompression. The small opening in the heart wall becomes plugged with clot and healing will take place. Waiting with careful observation is justified in this group, although one should be ready with prompt surgical interference should bleeding recur or tamponade develop.

Little attention has been given to the blunt or non-penetrating injuries of the heart and yet it is becoming increasingly apparent that these comprise an important group. During the past 10 years Bright and Beck in this country and several foreign workers have studied this type of trauma both experimentally and clinically. Very recently White and Glenby have written comprehensively and conservatively on the same subject reviewing the experimental work to date and citing numerous case reports. Hallermann states that from January 1, 1931 to August 1, 1934, 3,751 autopsies were performed at the Berlin Medicolegal Institute, of which 124, or 3.2 per cent, presented cardiac injuries due to blunt trauma. It is strange that so little attention has been given this subject in this country. Furthermore, much information can be obtained experimentally by studying injury and repair in healthy and artificially damaged hearts. Great credit is due to Beck and his co-workers and to Schlomka and Kuelbs for the important work they have already done along these lines. There is still much more to be accomplished, however, before a final appraisal of these injuries and their sequelae can be made.

Brahdy and Kahn state this admirably: "After the condition of the patient prior to the accident has been estimated, the nature of the injury itself must be considered. A detailed knowledge of the type of injury is extremely important and usually can be obtained from a detailed description of the accident. Was it a direct trauma (a blow or fall), an indirect trauma (a lift or a twist), or a psycho-

emotional injury"? Inasmuch as we are discussing only organic injury of the heart resulting from blunt trauma, crushing injuries, and sudden strain the psycho-emotional injury will not be considered although of itself it may be productive of alterations in rhythm and a cardiac psychoneurosis almost identical with some of the organic diseases.

Cardiac injury should be suspected following any blow over the left chest, the impact of the steering wheel in automobile accidents, or crushing of the chest. It should be thought of also in cases of falls from any appreciable height and considered as a possibility following violent and sudden strain or sudden severe pressure on the abdomen. White and Glenby give 5 simple and almost self-evident rules, which are, nevertheless, often overlooked. First, the more severe the injury to the thorax, the greater likelihood of cardiac damage. Second, "the more diseased the heart is, the more easily it is injured by trauma. Third, the more nervous and sensitive the subject, the more numerous will be the symptoms following trauma. Fourth, the signs of cardiac injury may or may not be evident on superficial examination. Fifth, prognosis depends not only on the damage to the heart itself but likewise on the associated lesions and efficacy of treatment.

Proper examination consists of careful inspection, palpation, percussion, auscultation, electrocardiogram, roentgenogram, and blood pressure determination. The results of such examinations should be recorded carefully and compared with repeated similar re-examinations during convalescence. Changes in the size of the heart and its sounds, the development of murmurs, alterations in rhythm, divergence from normal in the electrocardiogram, syncope, precordial pain, and attacks of angina pectoris should be noted especially.

Myocardial damage resulting from blunt trauma may vary from a small area of edema with a few pericardial or subendocardial hemorrhages to complete rupture. The extent depends on the violence of the injury and the pre-existing condition of the heart. A diseased heart is much more liable to injury than a normal one. Knelis and Straus have verified this experimentally using cats, dogs, and rabbits, and conclude that normal animals withstand even recurrent trauma without permanent injury. Experimentally produced cardiac defects, however, increase the sensitivity of the cardiac muscle so that even slight trauma may cause marked hemorrhage or acute cardiac death.

Under certain conditions, perhaps when the intraventricular pressure is high as in late diastole, even a normal heart may be affected seriously

by relatively mild trauma. Deutsch reports the case of a professional boxer 26 years of age in excellent physical condition and with normal heart and vascular system. In the third round of his last match he received a blow over the apex of the heart and died immediately. At autopsy dark red, delicate hemorrhages were found in the anterior mediastinum. The heart was rigid and contained only fluid blood, the wall of the left ventricle was 16 to 17 millimeters thick and the valves and coronary arteries were very delicate. The aorta was small and normal. The condition was described as cardiac enlargement without marked dilatation and blood stasis in the other viscera. Deutsch's explanation is that because of severe and acute physical strain and accelerated breathing the thick and rigid heart muscle showed a particularly increased tonus at the moment of death. This description agrees with the prolonged "peristole" mentioned by Schlomka.

The findings and opinion of Schlomka merit recording in detail. Cats and rabbits were used. (1) Simultaneously with the trauma the electrocardiogram shows disturbance of cardiac function. (2) coincident with the trauma the blood pressure usually shows a considerable decrease in proportion to the severity of the chest trauma. (3) this drop in blood pressure is accompanied by a temporary and often marked rise in venous pressure. (4) commotio cordis is typically associated with a frequently pronounced acute traumatic dilatation of the heart, preferably the right heart. In some cases there occurs a later secondary dilatation with recurring drop in blood pressure and rise in venous pressure and death. (5) Blunt trauma causes instantaneous death usually from fibrillation, from a fatal Stokes-Adams syndrome or rarely from sudden prolonged peristole. (6) surviving test animals frequently develop chronic heart lesions, generally myocardial, with resulting chronic dilatation.

Schlomka states that these experimental findings are verified clinicopathologically in (1) pulse irregularity as an acute symptom from extrasystoles, auricular fibrillation, disturbed conductivity with blocking or thready pulse due to pronounced and prolonged drop in blood pressure. (2) acute traumatic dilatation may be present. (3) instantaneous death may occur from ventricular fibrillation or as an apoplectic manifestation of Stokes-Adams syndrome.

The entire complex of acute cardiovascular and cerebral symptoms following blunt trauma of the chest wall must be interpreted as commotio cordis with subsequent acute and more or less lasting cardiac insufficiency. The electrocardiogram ex-

hibits coronary spasm indicating likewise a functional derangement in blood supply. When this condition is present, absolute bed rest and strict diet should be ordered, any surgery should be delayed if possible, venesection is indicated to relieve cardiac dilatation, vasodilators should be prescribed, warmth rather than an icebag should be used to relieve cardiac pain, intracardiac adrenalin is indicated if the pulse is impalpable and heart sounds cannot be heard, and artificial respiration may be necessary.

Quite apart from myocardial injury with the possible ensuing signs of dilatation and acute cardiac failure of greater or less degree, effects on the heart of non-penetrating trauma may manifest themselves as changes in rhythm such as extrasystoles, tachycardia, or auricular fibrillation, disturbance of the conduction system, and angina attacks. In 1924, the author assisted Dr S W and Dr A V S Lambert in the care of a patient of 57 who had received a violent blow over the precordium. There was syncope of very short duration following which he complained of severe paroxysmal precordial pain. Physical examination of the heart was persistently negative except for extrasystoles. The symptoms were paroxysmal pain, anxiety, slight dyspnea, and upper abdominal distention. Unfortunately, no electrocardiogram could be obtained because of the fact that he was at home and a portable electrocardiograph was not available. Absolute rest, daily colon irrigations, and morphine were prescribed, and later 0.1 gram of digitalis was given intravenously each day. The acute symptoms persisted for about 10 days, following which he made an uneventful convalescence over a period of 4 weeks and has remained well since. Here was a case of cardiac trauma from contusion manifesting itself by short syncope, extrasystoles, paroxysmal cardiac pain, and upper abdominal distention.

Rarely also the heart itself or one of its valves, may be ruptured subsequent to blunt trauma of the thorax, crushing, great strain, or sudden compression. Bright and Beck have analyzed the reported cases of cardiac rupture, and Antonini has discussed rupture of the valves. He points out that the immediate symptoms may consist of cough and hemoptysis or there may be none at all, and a murmur appearing at a variable time after the accident may be the only sign of rupture.

TREATMENT

In treating these various types of cardiac injury repeated and careful examinations, with electrocardiographic aid, should be made as already

mentioned. Absolute bed rest and light diet are essential. A Gatch bed is distinctly preferable. Every motion should be spared the patient, and sufficient sedation to control restlessness administered. All but the most urgent surgery or manipulations elsewhere on the body should be avoided. Signs of even slight cardiac failure should be carefully sought for and digitalis prescribed as indicated. Oxygen therapy is employed for dyspnea, cyanosis, and signs of cardiac failure. To reduce irritability and disturbances in the conduction system quinidine, or, for auricular fibrillation, digitalis may be indicated. An icebag may be helpful in the rapid arrhythmias. When the disturbance manifests itself by attacks of angina indicative of possible coronary spasm, vasodilators and oxygen are indicated and heat rather than cold should be used over the precordium, this is also true if acute dilatation or other signs of myocardial damage are present. Venesection is indicated in acute traumatic dilatation. Abdominal distention must be controlled by the judicious employment of cathartics, poultices or stupes, irrigations, and pituitrin, pitressin, or prostigmin as needed. Bed rest should be continued for from 5 to 8 weeks and a slow resumption of activity insisted upon. As soon as a diagnosis of an injury of this kind is suspected, the assistance and advice of a competent internist should be sought and therapy planned with him.

THE ESOPHAGUS

Although it may not be generally recognized, injuries of the esophagus are not infrequent. Needless to say they are extremely serious because of the thinness of its wall, its relatively scant blood supply, the poor resistance and localizing ability of the loose areolar tissue of the mediastinum to infection, and the type and virulence of the infection itself, which is always a mixture of aerobic and anaerobic organisms. Trauma is of 4 varieties: (1) chemical, (2) external, (3) internal from foreign bodies such as bones, and (4) instrumentation. The treatment for the first group is largely expectant with sedation and neutralizing and bland washes in the early stages and later dilatation as necessary. Wounds of the esophagus should be thoroughly débrided, carefully repaired, and the wound picked with active medicinal zinc peroxide. Internal trauma caused by foreign bodies or instrumentation is of frequent occurrence and is all too often followed by a diffuse mediastinitis or localizing abscess. If a person injures the esophagus by swallowing a bone or some other sharp foreign body, he should be esophagoscoped immediately, if possible, to

make sure that it is no longer present, and, if present, it should be removed. If, following trauma by such foreign body or from instrumentation the signs of perforation and spreading infection appear, prompt operation is not only indicated but is imperative. Such signs are chill, temperature, painful deglutition, and soreness in the neck or mediastinum. Physical examination may show tenderness or swelling, occasionally beginning subcutaneous crepitation, or nothing. Roentgenograms may show beginning abscess formation or the appearance of edema and gas bubbles. Esophagoscopy will demonstrate the site of the perforation. Drainage should be established by the shortest possible approach as determined from the information at hand. This may be directly into the mediastinum or at base of neck anterior to the sternomastoid muscle or by a collar incision. A tube should be inserted and the wound left wide open and packed with active zinc peroxide if available, if not, hydrogen peroxide or Dakin's solution, and the foot of the bed should be elevated.

It is difficult to understand the hesitancy with which many surgeons approach these esophageal lesions and their associated infections. Because of the very nature of the infection, its location, and the recognized poor reaction of the tissues toward localization, there must be no compromise or delay in establishing surgical drainage once the diagnosis is established and the approximate site determined. The lower pharynx, upper esophagus, and upper mediastinum may be readily reached by an incision low in the neck along the posterior or anterior border of the sternomastoid muscle. As the muscle and vessels are retracted the esophagus is approached. If infection is present there will be edema, bubbles of foul-smelling gas, or even a poorly walled-off abscess cavity. If the infection is limited and high in the neck, incision posterior to the sternomastoid muscle permits drainage by merely displacing the vascular sheath forward. Lower in the neck and in the upper mediastinum the incision is made along the anterior border of the muscle and this and the vascular sheath retracted laterally. This is not always possible however for where there is widespread infection without any evidence of localization the best approach is by a generous low collar incision, thus providing the freest drainage possible to both sides simultaneously. Counter incisions may be made as indicated at a later date. If the infection is further down but still above the level of the third rib, it may be drained by resecting the second costal cartilage on the right, displacing the pleura, and entering the upper mediastinum directly. The

lower esophagus may be approached from either side by removing a portion of one or more ribs from their angles backward including their articulating transverse processes of the vertebrae. As the pleura is displaced forward, the mediastinum is entered and readily explored. With the mediastinum thus accessible throughout its entire extent delay in operation is indefensible. The mortality high at best following this type of injury increases, however, as surgical drainage is delayed.

SUMMARY AND CONCLUSIONS

1. Except for large and dirty wounds, bleeding from internal mammary and intercostal vessels, and persistent pulmonary hemorrhage, the treatment of injuries of the chest wall, pleura, and lungs is conservative. All therapy is directed toward restoring the normal anatomy, physiology and dynamics within the chest as soon as possible. Aspiration of hemothorax and partial replacement with air is recommended. Immediate surgery is advised only for large or dirty wounds, and for active bleeding, usually from an intercostal or internal mammary vessel.

2. Immediate surgical repair is urgent for penetrating wounds of the heart. Blunt and non-penetrating cardiac trauma may result in organic—either myocardial or valvular—functional, or psycho-emotional disturbances. Diagnosis and treatment are outlined.

3. The treatment of esophageal perforation or injury is surgical and the use of zinc peroxide is recommended.

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TREATMENT OF FRACTURES OF THE SHAFT OF THE HUMERUS BY HANGING CAST

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SEVERAL features about the humerus cause fractures of that bone to present special problems in treatment (1) It is the most freely movable long bone. Articulated above with the scapula by a ball and socket joint, the humerus has movement in all directions, and its movement can be amplified by movement of the scapula. (2) Its entire function is that of a lever, so that nearly all stress is in tension or at an angle to its long axis. The bone has to stand comparatively little stress in compression. (3) When at rest while the person is standing, the axis of the bone hangs vertically and is influenced by gravity alone. These individual features of the humerus make it necessary to depart from common lines of treatment of fractures of long bones, and have caused those who give special attention to management of fractures to be grouped into 2 general classes.

The first of these might be designated properly as the rigid immobilizationists. Those who subscribe to the requirements of this method insist upon accurate reduction and then fixation in a neutral position for as long as is necessary to secure enough union so that displacement will not occur with slight motion.

There are many practical difficulties to the use of absolute fixation of the humerus. It is easy to

reduce a transverse fracture, but apposition of fragments is difficult to maintain, and when the break is very oblique or spiral, apposition is impossible. In these cases alignment must be maintained by continuous traction, and on a humerus this traction must be exerted with considerable caution lest distraction of fragments follow and cause delay or even failure of union. We have found that when continuous traction on the humerus is necessary, an excess of 6 pounds, with the elbow flexed, must be employed with great caution and should be checked frequently by fluoroscopic observation or films.

After reduction or alignment has been attained, the apparatus to maintain position must immobilize the shoulder and elbow, consequently, the body must be included in the dressing. Since rigid immobilization is followed by rapid wasting of the muscles about the shoulder girdle, particularly the deltoid, the arm should be fixed in as much abduction as possible, so that when dressings are removed, gravity will cause the arm to fall to the side and the deltoid muscle will not have been stretched. The common dressings in use are some form of aeroplane splint or a shoulder spica case, and the usual position is the humerus abducted 60 to 90 degrees and the elbow flexed, occasionally, the humerus is rotated externally.

Such a dressing is cumbersome and uncomfortable, it interferes with bathing, and since street clothing cannot be worn over this dressing, confinement to the house is enforced. Such a dressing

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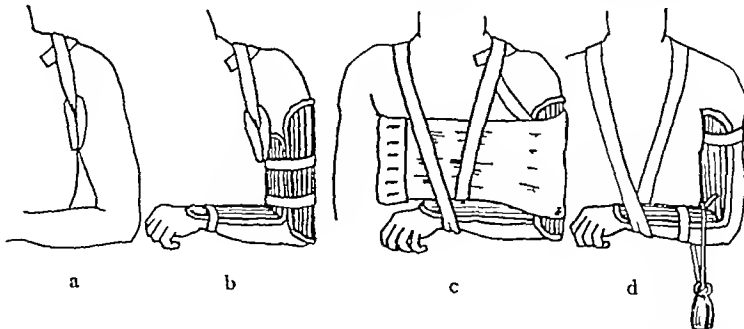


Fig. 1. Dressing for fracture of the shaft of the humerus, consisting of, a, pad in axilla held by a strap over shoulder, b, molded padded plaster of Paris metal, felt, or wood splints applied with forearm pronated, c, body swathe (muslin or gauze) and sling, d, weight attachment to be used if traction is needed.

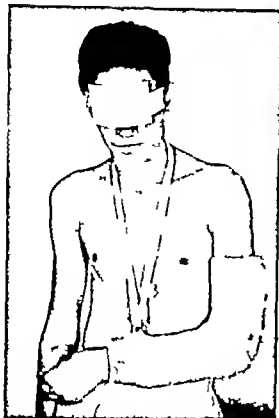


Fig. 2. Hanging cast which accomplishes the same result as the methods illustrated in Figure



Fig. 3. Showing the possibility of passive rotation of the arm in a hanging cast.

is well nigh impossible in the obese and others whose strength and endurance are reduced.

Those who in the management of fractures do not accept the necessity for absolute immobilization depend upon some form of traction in the long axis of the bone. This has long been a method of treatment in fractures of the femur as well as the humerus and, while accurate apposition of the fragments may not be accomplished, good functional result without deformity is usually secured. In the humerus, traction is accomplished by gravity; the weight is supplied by that portion of the arm below the fracture, and when necessary, this weight may be augmented by additional weight about the elbow. An old method was to apply coaptation splints to the surface of the humerus from shoulder to elbow, flex the elbow joint to 90 degrees, and hang the forearm by a narrow sling about the wrist. In this position the humerus was vertical when the patient was standing and if additional weight was required, a tobacco bag containing a variable quantity of shot was hung

as far up on the forearm as possible. The most objectionable feature of this dressing was the swaying, dangling weight which was difficult to keep in position and constantly caught and struck on objects which the patient passed.

For some years we have employed a modification of this dressing which does not alter the principles employed, is free from the objection mentioned, and when once applied does not need further attention. It has come to be known as the hanging cast or traction cast and in our hands as well as some others has given a high proportion of good results with least annoyance and discomfort to the patient. A plaster cast is applied from the axilla to the hand over stockinetts only. The elbow is flexed to 90 degrees, the forearm is in mid-pronation. A wire loop is incorporated in the cast just above the base of the thumb and through this a piece of bandage is threaded which passes about the patient's neck. We instituted the use of this loop when we found that patients would move the sling up the forearm toward the elbow



Fig 4 Early active movements to restore flexion and extension of the shoulder joint after cast is removed

in order to relieve the pull on the shoulder. When the fracture is high, near the insertion of the deltoid, the upper fragment is often abducted and causes angulation at the break. In such cases we place a wad of sheet cotton over the inner aspect of the elbow and cover this with plaster. This acts as does a Mitteldorff triangle, abducts the lower fragment, and aligns it with the upper fragment.

When the fracture is very oblique, spiral, or comminuted so that reduction can not be accomplished, or when the fracture is compound, or the

patient badly shocked, our common practice is to put the patient to bed and apply balanced traction with the arm abducted 45 degrees and the forearm flexed to 90 degrees. When reaction has subsided and the patient's vigor has returned, the hanging cast is applied.

Patients are cautioned not to rest their elbows on chair arms or other objects and to sleep with their shoulders well elevated. After 7 to 10 days the patient is instructed to rotate the humerus within limits of comfort, and in 2 weeks he is

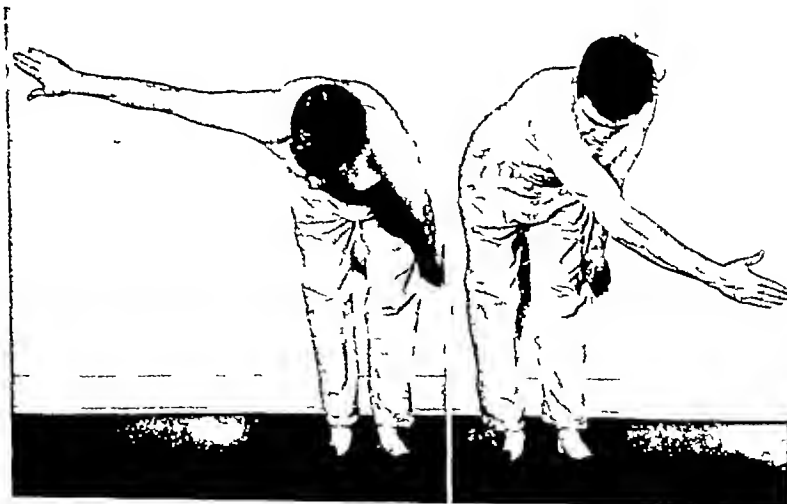


Fig 5 Active movements to restore abduction and adduction after cast is removed



Fig. 6. Hanging exercise to improve restoration of deltoid action.

directed to abduct his arm as far as he can comfortably. Usually in 4 weeks the cast can be removed and a sling substituted, and movements of rotation, swinging and abduction can be amplified.

With this treatment and regimen we have found that restoration of abductor function is delayed no more than when an aeroplane type of dressing is applied. Our reductions, while rarely showing 100 per cent apposition, do not often fall below 50 per cent. Union is usually complete in 8 weeks. It may be several months before the patient can raise his arm to the vertical position but we have rarely failed to have this function return eventually.

The series of cases analyzed consisted of 108 fractures of the shaft of the humerus. Fractures of the surgical neck and supracondylar fractures were not included. The 108 cases were located as follows: upper third, 25; middle third, 62; and lower third, 21.

Of the 59 patients treated by hanging cast, 22 had treatment for variable periods by balanced traction in bed. The shortest period of this treatment was 3 days; the longest 95 days; the latter was necessary because of extensive comminution from a gunshot wound followed by infection. The results obtained were as follows: Good union and

function 85; poor position, good function, 6; poor function 3; non-union, delayed union, 4; result not ascertainable 9.

The 3 patients whose results were classified as poor had impaired abduction of the humerus. These were patients who were inactive by reason of age or other disability and consequently unable to co-operate.

While the hanging cast method was used more than all other methods combined, the others used were similar in principle except that used in the 3 cases in which an aeroplane splint was used. That is to say that in all but the 3 patients in whom abduction was used, the arm was permitted to hang vertically so that gravity was exerted in the long axis of the humerus.

The principal argument in favor of an abduction method is that during convalescence it reduces the disability occasioned by the stretching of the deltoid muscle and by the delay of restoration of abduction which result. If a vertical hanging method is followed by results equal in this respect, this method is superior in every other way because of its greater simplicity and lighter weight.

A fair composite picture of the course in a moderately vigorous, co-operative adult would be

TABLE I.—TYPES OF FRACTURE

Gunshot wound
Compound
Oblique
Comminuted
Transverse
Spiral

No.
9
30
3
33
7

TABLE II.—TYPE OF TREATMENT

Swathe bleeding arm to side of chest
Mittelschmerz triangle and on the
Aeroplane splint
Pin traction followed by sling
Open fixation Parkman Martin band
Open fixation plate
Open fixation wire
Hanging cast
No treatment

No.
18
7
3
0
59

as follows. The application of a hanging cast for 6 weeks, with gradually increasing motion as discomfort diminished. This would be followed by a sling at 90 degrees with light use of the arm and several swinging exercises during the day. When all dressings are removed in 8 weeks, we would expect the patient to flex the elbow to 40 degrees, extend it to 135 degrees, abduct the humerus to 60 degrees, and have full rotation. In 3 months he should have full restoration of function.

In 19 cases, all adults, complete restoration had taken place after 3 months had elapsed and in some of these the period was less. One of these patients was 73 years old. Four had some impairment after 1 year, but in each case there was some good reason present for the delay.

One patient had an osteomyelitis following open operation. Four patients had radial nerve injuries, 3 of which were explored. Full radial nerve conduction was restored in all. In 1 patient there followed an acute painful osteoporosis.

CONCLUSIONS

1. Since the humerus when unsupported hangs vertically when the patient is erect, this position

will in most instances be followed by alignment of the fragments when the fracture is situated in the shaft.

2. The hanging cast reduces lateral motion, and when some lateral motion does take place it is assured that both fragments move through the same arc, and it is a convenient and comfortable way of applying traction by increasing the weight of the arm.

Abduction methods on an ambulatory patient are cumbersome, uncomfortable, and fatiguing and can not be used for all patients. These methods also prevent active movement which is the most effective method of restoring function.

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Fig. 6. Crawling exercise: Improves restoration of deltoid action.

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A fair, composite picture of the course of a moderately vigorous, co-operative adult would

TABLE I.—TYPES OF FRACTURE

Gunshot wound	1
Compound	9
Oblique	30
Comminuted	8
Transverse	23
Spiral	7

100

9

30

8

23

7

Swathe binding arm to side of chest	5
Mittelsdorf triangle and swathe	13
Aeroplane splint	7
Pain traction followed by sling	6
Open fixation Parkman-Martin band	59
Open fixation plate	
Open fixation wire	
Hanging cast	
No treatment	

as follows. The application of a hanging cast for 6 weeks, with gradually increasing motion as discomfort diminished. This would be followed by a sling at 90 degrees with light use of the arm and several swinging exercises during the day. When all dressings are removed in 8 weeks, we would expect the patient to flex the elbow to 40 degrees, extend it to 135 degrees, abduct the humerus to 60 degrees, and have full rotation. In 3 months he should have full restoration of function.

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SYMPOSIUM OPHTHALMOLOGY

PARALYSIS OF THE LOWER LID AND SCIERAL SCARS AND CRAFTS

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PARALYSIS OF THE LOWER LID

PARALYSIS or destruction of the orbicular muscle fibers of the lower eyelid can cause quite different and more severe symptoms than a similar catastrophe in the upper lid. Constant elevation of the latter can be caused by overactivity of the levator palpebrae muscle, and this is always in evidence, but as long as the tone of the lower lid is present, lack of normal activity is rather unnoticeable, especially if there is any persistence of those involuntary lid movements that normally cause the open fissure to frame the iris somewhat accurately during its ordinary up and down excursions. It is when the tone is lost that the paralyzed lower lid begins to attract attention subjectively and objectively (Figs. 5 and 6). Contact of the lid with the globe is the normal condition, and when this ceases there is a distinct sense of discomfort. The overacting levator muscle has no tendency to pull the upper tarsus away from the globe even when the latter is flaccid, as both gravity and a potential vacuum act to maintain this contact. On the other hand, gravity which helps to maintain the contact of the upper lid here has the reverse influence and atmospheric pressure lends no helping hand. The immediate reaction to even a slight separation of the tarsus is a sense of discomfort, which may develop into a distinct irritation or inflammation when particles of dirt or grit accumulate in the space formed between the globe and the lid. Excessive tearing may also result.

The most common cause of lid paralysis is total or partial loss in continuity of the seventh nerve (Fig. 8) while in some cases it is due to a local destruction of the muscle (Fig. 9). A binding scar or a depressed lower orbital border can prevent the lower lid from rising to its natural level or may even be the cause of an ectropion (Fig. 10).

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In some cases an external canthoplasty will be sufficient for the correction of these conditions. In others more intricate measures must be adopted the object of all of which is to hold the lid border at the level most common to its fellow and in good contact with the globe. With such a correction a static lower lid can be quite serviceable. In cases in which it is appropriate, the restoration of motor innervation is the ideal plan (Fig. 8). In the following reports, different plans to which we have resorted are illustrated.

CASE 1. This is a case of distortion and purely local paralysis of the lower lid due to extension of paranasitis which involved the lower lid and which resulted from the injection of an oil into the lacrimal sac in an attempt to force an opening through a blocked nasal duct. The lower two-thirds of the lid sagged away from the globe, but the outer third bordered as in entered by scar and the lashes swept the sclera. We first attempted to raise the lid by chiseling off 3 millimeters of the lower bony border; the latter was raised by inserting an ivory rod. This plan has worked nicely here, the lid has been pulled down by a depressed fracture of the border but it did no good in this case. The correction was accomplished by the use of a flap taken from the upper end of the forehead—base in front of the ear—and sutured into transverse opening in the lid just below the tarsus. If the cheek thins on which the lower border rests all giv. normal support, this rather stiff flap should in turn hold the tarsal border in place. At the same operation an arrowhead incision was made just internal to the inner canthus, and the point of the latter was drawn into the apex of this defect, thus as done back to narrow the canthus and move it toward Figure 11 shows the condition at first examination. Figure 12 shows the final result, which was quite satisfactory in every way. The grafted forehead defect is entirely hidden by slight draping down of patient's hair. The excessive tearing as relieved and the patient was satisfied with the appearance. This result constituted damage suit.

CASE 2. This patient had total paralysis of lower lid due to trauma and scar. Patient as in an automobile accident the tarsus of the cheek were torn outward as flap, the skin tear running downward from near the inner brow past the corner of the mouth, so close to the lower border of the mandible, and from thence back to the angle of the jaw. About tear ran back and across the middle part of the lower lid. There was parotid fistula loss of



Fig 1 Case 1 a, left, Distortion and local paralysis of lower lid at first examination, b, result after operation



Fig 2 Case 2 Patient with total paralysis of lower lid a, Condition at first examination, b, flap in place with ped-

icle still uncut, c, after cutting the pedicle, outer end of transplant fixed well above level of outer canthus

function of the temporofacial branches of the seventh nerve with inability to close the eye, and eversion and sagging of the lower lid on the left side. An attempt was made to correct the droop and ectropion by somewhat the same plan as was used in Case 1, but to give a positive upward pull. The insert was cut crescent shape and the points anchored above the level of the fissure, but in spite of several adjustments, this was never quite as satisfactory because the paralyzed cheek failed to give support to the transplanted flap and the patient's physical condition did

not warrant the use of fascia loops into the cheek. Figure 2a shows the condition at time of first examination. Figure 2b

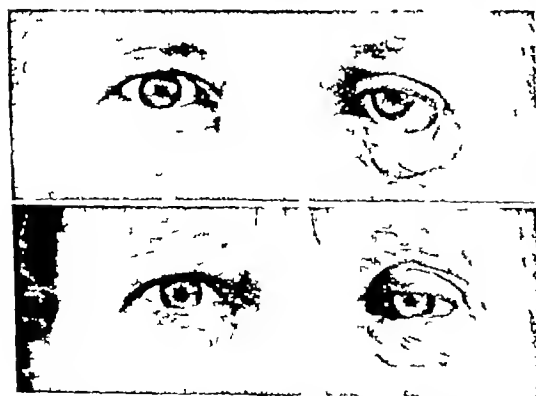


Fig 3 Case 3 Paralysis of lower lid incidental to investigation of an orbital antral tumor a, above, Condition before implantation of cartilage, b, result after operation



Fig 4 Case 4 Traumatic paralysis ectropion at inner canthus a, above, Illustrates sagging of lid away from the globe especially on its inner half, b, result after operation



Fig. 5. Case 5. Total paralysis of right side of face from peripheral nerve destruction. a and b, illustrate

ectropion of lower lid with overactivity of the levator palpebrae muscle. c and d, result after operation.

above the flap in place, pedicle still uncut, and illustrates how the point of this flap is put internal and above the level of the internal canthus. Figure 3c shows the last photograph taken just after cutting the pedicle, and also shows that the outer end of the transplant is fixed well above the level of the outer canthus (make hammock like support for the tarsus). An external canthoplasty here might have been helpful.

CASE 3. Paralysis of the lower lid incidental to breasting of an orbital antral tumor. In this instance, the lower lid was drawn downward by scar and was quite flabby and lifted with either uterine or forehead flap, could not have been suitable. Through an incision made at the lower border, the lid was dissected in layers almost to the tarsal border. Just this as inserted this band of preserved costal cartilage to serve as an anastomosis. This is possibly 3 millimeters wide and 5 millimeters long, its 3 centimeter wide base is sutured to the orbital border below with No. 000 silk, and the knif-like upper edge is fixed just above the newly made lid and sutured so as to hold the lid border at its proper level. This established contact between the globe and tarsal border except just 1 the lower punctum. The latter was subsequently brought into contact by excising a prism shaped piece of mucosa and tarsus from just below and by suturing the defect. Figure 3a shows the condition before implantation of the cartilage and Figure 3b the result. The fullness of the upper lid is edema following recent operation.

This plan is appropriate for an occasional case but its execution presents certain inherent technical difficulties. It can be done with live, uterine cartilage better than with the preserved. At the junction of the eighth and ninth cartilages, one can usually find a rather flat area from which a thin layer of both cartilage and perichondrium can be shaved. If this is the white cartilage of the young person, this would tend to curl with the concavity on the perichondrial surface. This can be released by cuts through the perichondrium

but a certain amount of bend is desirable to correspond to the forward bulge of the lid. Yellow cartilage does not curl so much. We have used a short piece of yellow cartilage side by side but we found it difficult to prevent the line of contact from being visible on the surface. The plan is also open to the objection that it gives a fullness rather than a transverse hollow at the base of the lid, but that can be the lesser of 2 evils.

CASE 4. Traumatic paralysis—ectropion at lower canthus. The patient had partial paralysis of upper lip, ala, and lower eyelid. On some sagging of the lid away from the globe especially on its lower half (Fig. 4a). The paralyzed upper lip and drooping ala were raised with fascia strips, and flap from upper lid, base toward nose, as switched into an incision just below the tarsus of the lower lid in an attempt to hold the lid up and against the globe. This failed but partially successful. Five months later fascia strip as passed hammock wire through the lower lid, the outer end, as fastened in the outer part of the acropostorbital muscle of the opposite side. This has maintained contact of the tarsus with the globe. In addition, surgical adhesion was made between the upper and lower borders of the inner canthus but almost obliterating the natural skin border of the canthus. The normal drainage of the tear through the puncta has been re-established (Fig. 4b).

CASE 5. Total paralysis of the right side of the face from peripheral nerve destruction. The face tissues are extremely flaccid and drooping on this side and there was an ectropion of the lower lid with overactivity of the levator palpebrae muscle (Fig. 5a and b). The face tissues were raised and held in this position by loops of fascia anchored above which took the strain of their weight from the lower lid. The outer fifth of the flaccid lower lid as excised, canthoplasty as done in addition, and also transverse elliptical excision of the overhanging excess skin of the upper lid. This gave fairly satisfactory result with good contact of the tarsus and the man can close his eye almost completely (Fig. 5c and d).

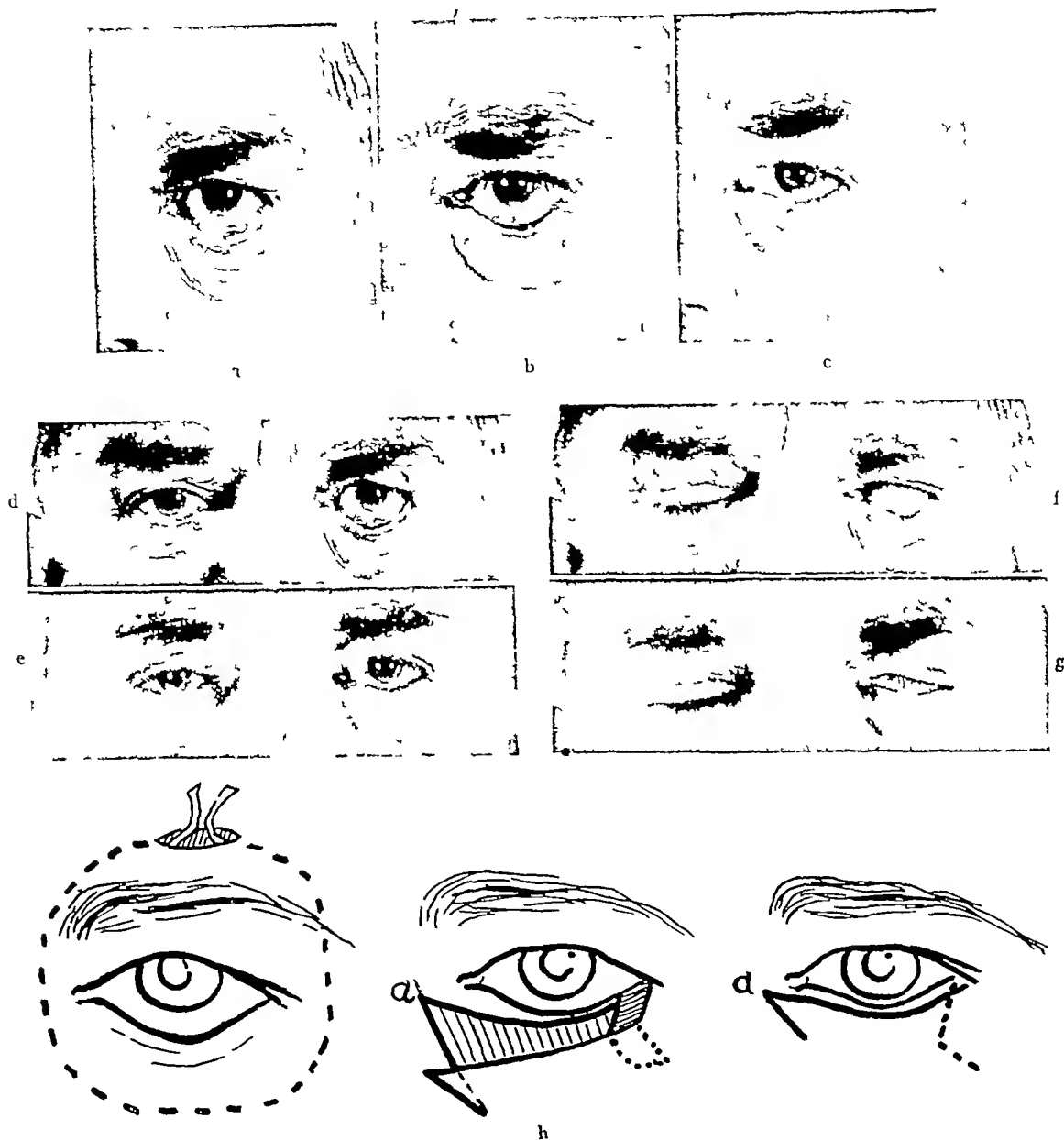


Fig 6 Case 6 Total paralysis of left side of face following removal of a parotid tumor a, b, and c, Show how and what was accomplished first by tendon loops alone and then by plastic operation on the lid d and e, Show a

comparison of the pre-operative and postoperative results with the normal open eye f and g, Show a comparison of the pre operative and postoperative results with normal closed eye e h, Diagram of operative procedure

CASE 6 Total paralysis of the left side of the face following removal of a parotid tumor This was done 5 years previous to our first examination For its correction the tissues of the left side of the face were first lifted and tightened after the plan used in Case 7, but with wider removal of the skin at the hairline At this time a strip of

fascia was made to traverse the base of the lower lid, and the 2 ends were passed subcutaneously upward, one internal to the inner canthus and the other external to the outer canthus, encircling the orbit and brow by traversing the lower part of the occipitofrontalis muscle (Fig 6a) The loop was closed by suturing the 2 ends together with fine



Fig. 7. Case 7. Total paralysis of right side of face following removal of acoustic neuroma. a, Shows the pre-operative condition with eyes open, b, shows attempted closure of eyes before operation and c, post-operative result. d, post-operative result. Diagram of operative procedure.

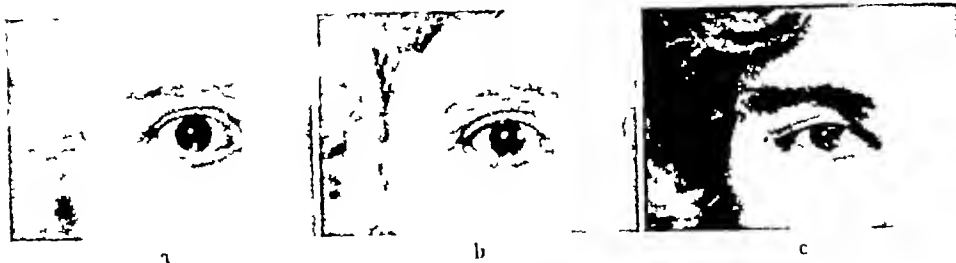


Fig. 8 Case 8 Destruction of trunk of seventh nerve within temporal bone. a, Shows condition at time of first examination, b, illustrates what was attained by lifting side

of face with fascial strips and putting one circumferential strip around the palpebral fissure, c, shows result 1 year after anastomosis

silk, after making and estimating the desired tension (Fig. 7c). This corrected the sagging lid only partially, which was not only particularly annoying on account of appearance and discomfort, but the constant tearing was embarrassing in the patient's work as a physician. This plan of using the circumferential fascial strip differed somewhat from that used in Cases 7 and 8, and was not as effectual. However, here we had to deal with much greater relaxation of the lid than in either of the 2 others. Three years later a tightening operation was done on the lower lid as follows (Fig. 6a). A skin incision was made, starting at point a, internal and above the inner canthus, running across the lower lid just beneath the lashes, skirting the outer canthus, and going 1 centimeter beyond. A second skin incision, starting at a divided the skin down to the orbital border, and this skin flap was undermined. A "dog leg" excision was made from the outer extremity of the tarsal border and lining tissues of the lower lid and this defect was closed by suture. The skin flap was shortened by removing a wedge from the inner end and the defect was closed by suturing, as was also the incision below the lashes (Fig. 6b and c).¹

Figures 6a, b, and c with diagrams show how and what was accomplished first by the tendon loops alone and then by the plastic operation on the lid. Figures 6d and e show a comparison of the pre-operative and postoperative results with the normal open eye. Figures 6f and g show a comparison of the pre-operative and postoperative results with the normal closed eye. The final photograph was taken 2 years after the lower lid adjustment, but since then there has been considerable stretching with corresponding droop of the lid and it is our intention to implant a shell of cartilage, as shown in Figure 3.

CASE 7 Total paralysis of the right side of the face following removal of an acoustic nerve tumor 12 years previously. The face distortion was corrected by implantations of fascial strips which engaged the apportion muscles of the opposite side, while the cheek was supported by a loop that engaged the buccal labial fold. These were fastened above and laterally in the parotid and temporal fascia with fine silk sutures. At the same operation a wide crescentic excision was made of the excess skin and tissue in front of the ear and in the hair line. The borders of the defect were approximated with fine buried silk. The sag of the lower lid and the over action of the levator palpebrae muscle were much improved by the use of a circumferential

strip of fascia lata. An incision was made 1 centimeter behind the external canthus down to the fixed tissue, also a semilunar incision around the internal canthus exposed the inner palpebral ligament. Through the external incision a "surgical" (curved) needle carrying a fascial strip was made to traverse the upper lid, coming out at the middle of the lid near its upper border, and re-entering, emerging through the semilunar incision mesial to the internal canthus. Where this strip crossed the internal palpebral ligament, it was attached to the latter with 2 loops of silk suture, but these loops were not tied at this time. The fascia carrying needle was then made to encircle the lower lid and to emerge through the internal incision. The sutures at the internal palpebral ligament were tied and the upper strand of fascia was attached externally at the outer canthus with enough tension partially to restrain the levator palpebrae muscle. Then the 2 ends of fascia were sutured together and fastened in the usual manner with several fine silk sutures with enough fascial tension to give proper support to the lid (Fig. 7c). Figure 7a shows the pre-operative condition with eyes open. Figure 7b shows the final result. Note the decreased vertical width of the fissure. Figure 7c shows attempted closure of the eye before operation. Figure 7d shows the postoperative result which was obtained by operation.

A study of these photographs suggests the possibility that a still better result might have been obtained if the lower loop had been placed a little higher in the lower lid and had also been drawn a little tighter.

CASE 8 Destruction of the trunk of the seventh nerve within the temporal bone 15 months previously. Figure 8a shows the condition at our first examination, the whole of that side of the face was paralyzed completely. Figure 8b shows what was attained by lifting that side of the face with fascial strips and putting one circumferential strip around the palpebral fissure, as was done later in Case 7, except that careful anchorage of the fascia just mesial to the inner canthus was omitted. Previously we had made an anastomosis of the cut seventh nerve to the spinal accessory nerve and the fascial loops were used to raise and fix the paralyzed tissue to get immediate improvement on account of the mental state of the patient. The latter somewhat lessened the vertical height of the fissure as is shown by comparing Figure 8b with 8a. Figure 8c, taken 1 year after the anastomosis, shows the further improvement that resulted from the re-innervation of the face muscles. The slight vertical ridge shown between the nose and the internal canthus marks the course of the fascia which has drawn slightly away from the periosteum. This ridge might even now be eliminated by excising a bit of the fascia loop.

¹This operation was done in May, 1937, and is somewhat of an exaggeration of the ideas presented by Dr. John W. Wheeler at the Second Congress of the Pan-Pacific Surgical Association 1936 and published in their Proceedings pp. 228-229 and also in the 'Collected Papers of John Martin Wheeler' pp. 338-342 entitled 'Halving Wounds in Facial Plastic Surgery'.

SCLERAL SCARS AND GRAFTS

Certain bleeding scars situated within the conjunctival sac can compromise normal vision by limiting proper lid clearance or free movements of the globe, and in addition may cause actual discomfort. These are most commonly caused by chemical burns, lye in children, and often thrown or splattered acid in adults, while trauma or infections will account for a few. These scars usually represent a much greater loss of conjunctiva than the area that has closed the defect. For the surgical correction of symptoms, not only must the limiting scar be divided or removed, but the loss must be remedied, either by conjunctival shifting or by the implantation of free grafts. We, personally, have had no experience with free grafts of mucous membrane, for 5 reasons: (1) They must of necessity be relatively small because of the scarcity of available material to draw from. (2) Our experience with skin grafts leads us to believe that a homomucous graft would not remain permanently, except in identical twins. (3) Free skin grafts of any size are easily and quickly obtainable. (4) In replacing large losses from the oral mucosa with free skin grafts, we have had very few failures of the graft to take, and almost no complaints about the final result when the graft had been sufficiently large. We have had similar experience in enlarging eye sockets or releasing the lids to facilitate better fitting of an artificial eye. We have had quite a number of the latter come in for re-operation—our own or the other fellow's—and the fault has usually been a matter of the quantity not of the quality or the position of the graft already implanted. (5) In cases in which it is practical we have avoided placing a skin graft in apposition to the cornea, but the late John Wheeler felt that it is a safe procedure.

A free autotissue graft placed in the socket will for a time exfoliate, give off an excess of sebaceous

discharge, and may also apparently irritate and joining normal conjunctiva into excessive mucous secretion, but given a socket of proper shape comfortably fitting eye, sufficient lining and a reasonable postoperative recovery period, I think there will be few instances in which the skin-lined socket will not prove relatively if not quite, satisfactory. However, when all or nearly all of the normal mucous lining has been replaced by skin, dryness of the empty socket has proved somewhat annoying.

Based on the observations and experiences cited, we were, when confronted with a case of a lower lid fixed by scar to the lower half of the sclera and cornea, emboldened to free the globe and substitute a split skin graft for the lacking mucosa both of the lid and of the sclera (Fig. 9). This is but another application of the outlay graft contrived by Gillies, Waldron, and their Sidcup Hospital associates as a substitute for a "Ever

Inlay" graft in replacing burn losses of skin of the eyelids. The use of this same plan within the mouth was just a step and from thence to the empty eye socket was but another. If a patient is in good condition, asepsis is present, and hemorrhage has been controlled, the proper set of the graft will depend largely upon the tension with which the tissues are drawn around a graft-covered form of wax or other material that snugly fits into the sulcus to be lined or against the raw surface to be covered. With careful consideration of the conditions found in the damaged mouth, this is not ordinarily a very difficult matter to one familiar with the use of skin grafts when, however, a graft is to be applied to a scleral eye, the technique is far from simple, and the possibilities of grief much greater. In the first place, all the precautions and safeguards that accumulated ophthalmological experience demands in undertaking any operation within the con-



b

FIG. 9. Case 1. a, Burn obliteration of lower sulcus. b, Outer three-quarters of lower half of conjunctival sac obliterated. lower lid attached as high as middle of

cornea and globe almost completely fixed. b, Scarred but rim of sulcus for rubber dam drawn. c, Night area at border of center of lower lid not covered. (th graft.

junctival sac must be exercised here in addition to the complexities inherent to an operation that, if done in any other part of the body, would be classed as a general surgical procedure. In incising or removing scars, the damaged sclera must not be punctured, the outlets of the lacrimal gland ducts should not be obliterated, and the attachment of the recti and oblique muscles must be respected.

Above all, the cornea is the greatest source of concern. In the whole course of the operation, it should not be touched by a gauze sponge, and even quite wet cotton or the gloved finger is not free from objection, also, the cornea should never be allowed to dry. This drying is prevented in ordinary ophthalmological operations by frequent or constant bathing with saline solution from a dropper. This latter procedure might not be best for implantation of the graft, but consideration of the cornea should come first, it is an avascular structure which has little resistance to pressure and the normal lining of the normal upper eyelid is its accustomed and safest contact. In the dissection, the scar should not be removed from the cornea at this time, it can be done more safely later, nor should one dissect too closely to the sclera as the full thickness of this wall might have been burnt through in places. However, lumpy or fringed scar projections should be shaved off smoothly before the graft is applied. To avoid harmful, uneven pressure on a denuded sclera that might be quite thin in places, one may choose for the supporting form a soft padding material, such as damp cotton, or some sort of pliable wax that will hold its given shape but will, at body temperature, also further adapt its form to that of the contacting tissues. We have used cotton in several instances, and in others paraffin that can be molded when submerged in water warm enough to be comfortably borne by the hand.

Our experience, which is here presented not without considerable diffidence, is limited to 8 scleral grafting operations on 6 different eyes. Though the graft "took" in every instance, still the postoperative course of each of these operations was complicated by a corneal irritation, or an ultimately controlled ulcer occurred in half of them. However, I now believe that this occurrence was due to technical errors and was not essential to the method. This conclusion is based upon a recheck of circumstances and occurrences related to these 8 operations, and this recheck also fosters a conviction that risk of occurrence would be lessened, or the extent and depth of the ulceration would be more easily controlled, if the following precautions were adopted. (1) Each step

of the whole operation, whether done in one or several stages, should, as far as possible, be foreseen and individually planned, and the sequence of procedure decided before the operation is started. It will go far to insure final success of the whole procedure to have the individual steps carried out smoothly and in proper sequence. (2) A paraffin form rather than cotton should be used when the raw area to be grafted is in close proximity to the cornea. A certain amount of excess skin is necessary in fitting the graft to the form, but that part of the graft not in direct contact with a raw surface quickly macerates, because it is in a bath of warm tears. This will soon allow the cotton to break through the restraining, non-attached part of the graft and it might come into contact with the cornea. (3) The form supporting the graft, whether cotton or wax, should be removed early, allowing it to remain in place 2 or possibly 3 days at the longest. A "taking" graft will have a blood supply, and will be adherent to its new bed within 24 hours. Upon removal of the form or stent,¹ one should be able, with an anesthetic, local or general if need be, to trim the unattached excess graft right up to the limit of the grafted area. Maceration quickly changes to putrefaction, but early removal of the form or "stent" makes possible the elimination of these potential corneal irritants. (4) After 1 or 2 days, the conjunctival sac may be irrigated cautiously with normal saline solution or any indicated medicant. If a drug will not injure the eye, it is not likely to injure the graft.

It should be borne in mind that not all these recommendations are based on the authority of direct observation, some are deductions drawn from reconsiderations of the circumstances of disaster.

In dissecting deeply alongside the globe, the attachments of the ocular muscles must be avoided, but this sulcus should be made deep enough to allow the orbital fat to present within its depth. When this occurs, it not only means that the adhesions have been divided, but also that adherence of the fornix of the infolded graft adhering to this ring or arc of fat will permit some mobility of the globe. This movement may be slight at first, but with just a little play established it will gradually increase as the result of the activity of extrinsic eye muscles. On theoretical grounds, one might expect that as subsequent contraction of the graft lessens the depth of the sulcus, the forward movement of the fornix

¹The word "stent," was coined among the British, possibly at Sidcup Hospital, to designate the graft-carrying form named after the man who made the dental modeling compound that they first used with their outlay grafts.



Fig 13 Case 13 Lid destruction and scleral adhesions from glass cut and infection a and b, Patient when first seen showing inner canthus drawn forward on the side

of the nose, c, showing corneal ulcer after operation but graft satisfactory, d, lining graft sutured to bordering skin, e, the final result

corneal scar (Fig 12c) The patient is now comfortable and the recent ulceration has healed, leaving no increase in the original corneal scar, and while the increase in ocular movement is objectively not very evident, her previous diplopia on external rotation has been eliminated almost entirely

CASE 13 Lid destruction and scleral adhesions from glass cut and infection In addition to extensive injuries in other parts of the face, the levator palpebrae muscle had been severed, almost all of each mesial third of both lids had been destroyed along with the corresponding parts of the palpebral and scleral conjunctiva, and while healing the inner canthus had been drawn forward on the side of the nose (Fig 13a and b)

The missing skin of the eyelids and of the side of the nose adjacent to the canthus was restored and the canthus was eventually worked backward toward its proper position by 3 repetitions of the following procedure done with but slight variation A vertical simular or trapdoor incision down to the periosteum was made at the junction of the lids with the nose, and the undermining was done both toward the nasal bridge and also outward, removing all scar from the periosteum but leaving a thin layer of scar where the periosteum was missing In this way a defect could be obtained at each sitting, into which was sutured a full thickness postaural skin graft, each suture engaged the bordering skin edge, the graft edge, and the underlying periosteum or scar Proper lateral tension could be made on the graft and deep contact maintained by tying the suture ends over a cotton stent An external canthotomy was done and the function of the severed levator palpebrae muscle was replaced by a fascia lata loop that connected the upper tarsus with the occipitofrontalis muscle, but the newly restored inner portion of the lids and inner canthus were still adherent to the globe (Fig 13b) These were

freed by dissecting deeply and implanting a split skin graft on cotton stent As usual, there was considerable post-operative reaction and an easily controlled corneal ulcer, but the graft proved satisfactory (Fig 13c) The operation was completed with an internal canthotomy at which the lining graft was sutured to the bordering skin (Fig 13d) Figure 13a shows patient when she first came to us, and Figure 13e the final result

Since this paper was presented before the American College of Surgeons, Dr George H Cross of Chester Pennsylvania has informed us that he has successfully applied Thiersch grafts to the sclera which were held in place by a thin silver shell made for him by Pilling and Sons Also Dr Charles H May has sent us a reprint of his article "Restoration of the Conjunctival Cul-de Sac in a Case of Total Symblepharon by Means of Thiersch Skin Grafts," which appeared in the *Archives of Ophthalmology*, 1899 28 No 2 He there describes a case in which he had successfully restored the conjunctival sac for the retention of an artificial eye He used a porcelain shell such as forms the base of an artificial eye to support the grafts after the lids had been dissected free from the globe He also relates that Dr Chambers of Jersey City had, in a case of partial symblepharon, used an ordinary button covered with gauze to support the graft and that Dr Chambers had reported this to the Ophthalmological Section of the New York Academy of Medicine some 2 or 3 years previously and that subsequently Dr Marple had presented two similar cases of successful result by this method in partial symblepharon Dr May also cites that Morton, of Minneapolis, *Ophthalmic Record* 1898 August recommended the use of a prosthesis after the grafts had been inserted and held in place by a line of sutures, reporting several successful cases in which he had operated in this manner with the object of restoring the fornix for the retention of an artificial eye Apparently in all these cases the lids were released to facilitate the fitting of an artificial eye

We are indebted to certain of our ophthalmological friends who cared for ocular complications in some of these cases, most frequently to the Drs. Post and Sanders who also read this manuscript.

BLEPHAROPTOSIS

The Technique Of Its Surgical Correction

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BLEPHAROPTOSIS may be defined as any drooping of either or both upper eyelids. It indicates a weakness of the levator or of the smooth muscle of the upper lid. The weakness of the levator and smooth muscle may be (1) local in origin as, for example, by traumatic infiltration (2) it may be due to muscle degeneration as in progressive muscular atrophy (3) it may be due to peripheral, or (4) central nervous disorders. The conditions of mechanical interference with the action of the upper eyelid, as for example by inflammatory or scar tissue or by tumor formation are beyond the scope of this paper and will not be considered here.

The need for surgical correction of blepharoptosis. The need for the operation may be the uncovering of the pupil as in a congenital case to permit the function of the eye to develop or it may be the correction of a faulty head position and facial distortion in either a congenital or acquired condition. The decision to operate upon a patient with blepharoptosis will depend upon the general condition of the patient, the question of whether or not the cause of the drooping eyelid is inactive and upon the condition of the lids and eyes.

Pre-operative examination. The pre-operative data required for the choice of the proper technique to be employed in the individual case are (1) The vertical width of the palpebral fissure with eyes level, with eyes elevated, and with eyes depressed. Photographs should be taken in these 3 positions. The measurements should be compared with those of the patient when employing the aid of the frontalis muscles, arching his brows, corrugating his forehead, with the head thrown back and also with the head level and the brows depressed by the fingers of the observer. The latter measurements give the index of the true strength of elevator power of the muscles of the upper eyelids when acting alone. (2) The horizontal width of the palpebral fissure as measured from the angle of the internal canthus to that of the external canthus by tangent and marginal

measurements. (3) Exophthalmometer reading (4) The sensitivity of and the ability of the cornea to withstand exposure. (5) The effect of cocaine on the smooth muscle of the lid.

ANALYSIS OF REPORTED TECHNIQUE AND PROCEDURES

The multiplicity of techniques for the surgical correction of ptosis is an indication of the unsatisfactory results which follow the best efforts in the hands of the most accomplished and experienced surgeons. Nearly everyone has tried to improve on the published techniques. No one surgeon has the opportunity to do many operations for this condition as it is relatively rare. It will be illuminating to consider the various operations by grouping them not under the names of the surgeons connected with them, but under the specific class within which the operation falls.

The removal of skin or of full thickness of the eyelid and the creation of cicatricial bands which by their contraction pull up the lid. The removal of skin is indicated when it is redundant as in blepharochalasis, but the production of lagophthalmos and exposure of the cornea is contraindicated. The removal of a portion of the thickened tarsus is indicated in trachoma although this opinion may need modification. Solftanilamide should be used before resorting to surgery.

2. *The natural method of improvement of function of the levator and smooth muscle where partial function remains.* This gives the most satisfactory results and should be employed whenever it is possible to get sufficient effect. It may be accomplished by resection of the tarsus and retraction or advancement of the levator and smooth muscle. The approach through the skin or through the conjunctiva is used. The direct indication for these procedures exists when the muscles show partial function particularly with the brows held down and when under these conditions the palpebral fissure is wider on upward than on downward gaze.

3. *The transplantation of the superior rectus muscle from the globe to the lid permitting the use of the elevating power of the superior rectus and inferior oblique when the levator and smooth muscles are almost or entirely inactive.* It will be indicated

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when the palpebral fissure is actually narrower on upward than on downward gaze. This phenomenon is produced by the movements of the lower lid on the excursions of the eye while the upper lid remains inactive. The question of whether or not this procedure should be used only when the superior rectus is strong has been debated a great deal. In the opinion of the author it may be done even when the superior rectus is completely paralyzed, provided the inferior oblique is active and strong and there is no hypotropia. If the superior oblique is also paralyzed, the condition of paralysis of elevation exists which is probably central in origin and which requires separate consideration.

4 *The procedures for the correction of paralysis of elevation* are complicated as there remains no normal elevating power. The immediate use of the frontalis to elevate the lid is contra-indicated as this would only expose the eye in a useless position of hypotropia. Wheeler made use of advancement of the inert tissues of the inferior oblique over the orbital margin and of the superior rectus on the globe and of a union of lid and globe. The palpebral fissure will not be wide, usually only part of the pupil is exposed and the orbicularis is sufficient to effect the protective closure of the lids. After the globe has been lifted from its position of hypotropia the union of the frontalis muscle may well be applied to elevate the eyelid. It might be possible in third nerve paralysis to detach the superior oblique from the globe, free it from its trochlea and after shortening it reattach it to the globe and lid for elevating power. Wiener has employed this procedure for replacing the function of the internal rectus but I have never seen it used for elevation.

5 *The employment or enhancement of the vicarious action of the frontalis muscle* may be had by uniting this muscle to the tissues of the upper lid by various means. The presence of facial distortion in ptosis by frontalis action is to be avoided. The pull of the frontalis is straight up and not a normal roll-back over the convexity of the globe.

With this analysis of the principles involved in the surgical correction of ptosis we may proceed to the consideration of the techniques which have proved satisfactory for certain purposes in the hands of the author.

TECHNIQUES OF VARIOUS PROCEDURES ADVOCATED BY THE AUTHOR

1 *The removal of skin* is indicated when it is redundant and falling down in folds as in blepharochalasis. Large pieces of normal skin have been

removed from the upper lids of patients for use as free grafts without production of any permanent shortening of the upper lid and with no lagophthalmos. It is my opinion that in the average case of ptosis there is no point in the removal of skin as this skin is usually not in excess. If the skin is made adherent in the position of the normal crease, the apparent redundancy will disappear and a useful purpose will have been served. The procedure will be directly indicated in the Mongolian type of eyelid where there is no crease and where the skin pushes down over the lid margin and the lashes.

No special description need be given concerning this procedure of removing redundant skin. The area to be removed is carefully estimated and marked out and is usually found to be elliptical. Incisions which are kept within the thin skin of the lid heal gracefully without scar formation. The incisions must not be carried too far nasally because of the danger of formation of cicatricial epicanthus. There should be no lagophthalmos at the completion of this operation as no effort should be made to correct real ptosis due to weakness of the levator or smooth muscles of the lid by the removal of skin alone. The removal of normal subcutaneous tissue, the production of deep scars or bands of contraction by traumatic surgery, infection or deep sutures so that the upper lid is joined to the brow, do not constitute good surgery. The lagophthalmos due to ankyloblepharon or ectropion which may result will prove very undesirable. The through-and-through resection of skin, subcutaneous tissue, muscle, and conjunctiva, as for example by the method of de Grandmont, is radical surgery. As much as is necessary might well be accomplished in a suitable case by resection of the muscle, tendon, and tarsal tissues.

2 *The use of the vicarious action of the frontalis muscle*. The author has never been in favor of the employment of this principle in ptosis surgery because it only enhances the undesirable characteristic facies of ptosis and leads to a straight upward pull of the upper lid. The implantation of foreign material, deep long sutures, wire, kangaroo tendon, fascia lata, the burial of dermis and epidermis, I believe, are all contra-indicated. If I were to advocate any use of the frontalis, I would do it by the Reese (18) method, which entails a union of strips of orbicularis to the frontalis. There may be a place for this operation in which all the normal elevators of the globe and lid are paralyzed.

3 *The resection of the tarsus and resection and advancement of the levator and smooth muscle of*



Fig. 4. Congenital ptosis with epicanthias.

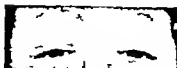


Fig. 5. Congenital ptosis without epicanthias.

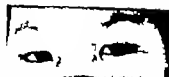


Fig. 6. Ptosis with Mongolian fold.

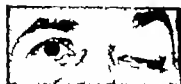


Fig. 7. Ptosis due to paralysis of third nerve.



Fig. 8. Ptosis caused by hyperthyroidism.



Fig. 9. Ptosis in progressive, senile atrophy.

the lid. It seems logical and natural in cases of partial ptosis to enhance the remaining function of the levator and smooth muscle of the upper lid. The principle of developing the partial function of the levator and smooth muscle was probably used for years before the first description of the exact technique by Bowman. The upper lid was everted strongly. The incision was made through the conjunctiva along the length of the superior border of the tarsus. The conjunctiva was dissected back with scissors and forceps so as to expose the tendon of the levator and superior tarsal border. Two or 3 sutures were passed through the levator about 2 centimeters back of its insertion. The muscle tissue was then resected in front of the line of sutures together with the superior border of the tarsus to which it is attached. The needles on the sutures were passed through the free border of the tarsus, and the levator and smooth muscles attached to their new position. The name most commonly associated with the use of this principle is that of de Blaakovsky. Years before de Blaakovsky published his paper Wheeler had employed a satisfactory technique for resection of the levator through the conjunctiva and had many successful results but never published his method. The Eversbusch method of resection and advancement of the levator through the skin is interesting in some cases and the author has used it with gratifying results, but the ease of the procedure of operating through the conjunctiva, the possibility of accurate placement of sutures, the gauging of results by the extent of the tissues resected have led him to adopt a modification of Wheeler's technique. The changes described are simply differences in suture material and in the plan of the insertion of sutures. The direction and plan of the operation

is as Wheeler (24) employed it except for a single principle of advancement of the resected muscle as given to the author by A. B. Reece (17). The direct indication for the use of this procedure is in a case of ptosis in which the palpebral fissure is wider on upward than on downward gaze.

4. *Technique of resection and advancement of the levator and smooth muscle of the lid with or without resection of the tarsus.* Local anesthesia by procaine infiltration and block, a combination of avertin per rectum and local anesthesia, or better still avertin and general anesthesia may be used. The usual skin and conjunctival preparations are employed.

The degree of partial ptosis has been recorded and it is estimated roughly that for each millimeter of ptosis to be corrected 2 millimeter of tarsus or 3 millimeters of muscle tissue will be resected. For example with a normal right palpebral fissure of 10 millimeters and a left ptosis of 6 millimeters, the left palpebral fissure being 4 millimeters wide vertically the desired correction should be 6 millimeters of improvement in elevation of the left upper lid. This might be accomplished by resecting the left tarsus 3 millimeters and the levator and smooth muscle 6 millimeters figuring 2 millimeter of tarsus and 2 millimeters of levator and smooth muscle for each millimeter of ptosis correction. It will probably be found that it is best to be generous and to do a little more than this, because the tissues are stretched by the application of the everting lid clamp. In general, however if there is no stripping of muscular fibers and no opening or loss of sutures, the correction given will be adequate. It is important not to include in the suturing any firm inelastic tissue such as the fixed tarso-orbital septum.



Fig 7

Fig 7 Ptosis due to heavy tarsus of right eye. Resection of tarsus indicated.



Fig 8

Fig 8 Eyes level, ptosis of 3.5 to 4 millimeters.



Fig 9

Fig 9 Eyes up, palpebral fissure wider than with eyes down. Direct indication for resection of levator and smooth muscle of the lid.



Fig 10, left Eyes down, palpebral fissure narrower than with eyes up.



Fig 11 Result after resection of levator and smooth muscle.

The lid is everted on an Erhardt¹ lid clamp. A heavy wide tarsus will be resected more than a narrow tarsus. The division of the resection between tarsus and muscle will be made according to the tarsus and the evidence of remaining strength of the muscle.

Step 1 A curvilinear incision is made with a scalpel along the entire everted conjunctiva just at the upper border of the tarsus. A line of cleavage is quickly and easily found between the conjunctiva and the smooth muscle which is attached to the tarsus. This line is followed by sharp scissors' dissection upward, this is facilitated if the assistant will carefully lift up the edges of the conjunctiva with 2 pairs of Lester forceps². The dissection is carried back to variable distances on an average of about 8 to 10 millimeters.

Step 2 A second curvilinear incision parallel to the first is then made. In some cases it is well to produce an arch which will simulate the normal arch of the lid, rising more sharply on the nasal side, the highest point is above the nasal edge of the pupil and falls off gradually on the temporal side. The second incision in the tarsus is made through to the orbicularis, the tension of the tissues causes the wound to gape and the second plane of dissection is easily found. Two pairs of forceps hold the tarsus and muscle up vertically, and the scissors follow the dissection sharply backward as far as necessary. The flat, voluntary, and smooth muscle band is well and easily shaped.

Step 3 Sutures (a) Two double armed No. 0000 10 day chromic catgut sutures with atrau-

¹Clamp designed by Miss Erhardt at the New York Eye and Ear Infirmary.

²Forceps designed by Dr. Lester, assistant surgeon, New York Eye and Ear Infirmary.

matic needles are looped from the conjunctival side through the muscle fibers and then relooped so that the parallel muscle fibers will be cinched and not permitted to slip through the suture but still will not be strangulated. (b) Three double-armed No. 0000 silk with atraumatic needles are passed parallel through the muscle fibers from the orbicularis side and then through the conjunctiva. The catgut sutures are in the central body of the muscle and the silk sutures are arranged 1 on each side and 1 between the catgut sutures. These 5 sutures are not too many and are all important.

Step 4 The predetermined length of tarsus and muscle tissues is then removed up to the sutures by scissors' resection. Care should be taken not to cut the sutures and not to cut the parallel muscle fibers too closely to the sutures.

Step 5 The catgut strands are carried into the pouch between the tarsus and orbicularis sutures. The dense tissue on the face of the tarsus thus effects an anchoring and advancement of the cut muscle fibers as suggested by Reese. The silk strands, which are through the mucous side of the conjunctiva, are passed through the thickness of the tarsus and lid and brought out through the skin, the needles are passed through small individual rubber plates and tied. The exit through the skin will be found to vary according to the tarsus which has been resected, but usually it is about 5 millimeters above the lid margin. This protects the lashes and tends to prevent eversion of the lid margin and distortion of the lashes. It also helps with the buried catgut sutures to form the very useful crease and fold in the lid which enhances the natural appearance and action of the lid in elevation. Criticism of the number of

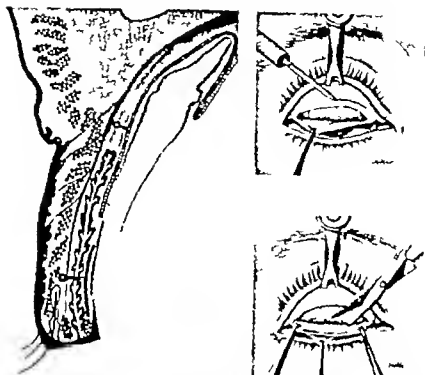


Fig. 3, left. Schematic section of the eyelid showing the levator and smooth muscles and their attachments to the skin and tarsus.

Fig. 3, right. Above. The upper eyelid is everted on a clamp. The first incision and dissection separates the conjunctiva from the muscles.

Fig. 4. The second incision is through the tarsus or muscle, permitting dissection of the muscles (levator and smooth muscle).

sutures employed will arise but this may be anticipated and explained. Too much care cannot be exercised in preventing the slipping of parallel muscle fibers through the lines of sutures. This method develops a skin crease or fold which is so important for the life and expression of the eye.

Dressing. When this operation is performed under local anesthesia, there is no lagophthalmos because the swelling of the tissues with the infiltration of novocain and the reaction to the operation depresses the lid and masks the effect of the correction of the ptosis. If general anesthesia is used, there may be some exposure of the globe requiring a special dressing which was devised by Wheeler (24). This dressing is best described in the section devoted to the use of the superior rectus in the correction of ptosis, because after this latter procedure, it is definitely necessary to use cone-shaped dressings or conical shields which rest on the margins of the orbit, or a special suture such as Frost devised for bringing up the lower lid to cover the exposed globe.

The dressing is changed after 48 hours. The silk sutures are removed after 5 days. The immediate result in view of the edema is apt to be disappointing to the patient. It takes several weeks in some cases for the full effect to be evident. Some of the most gratifying results are obtained when this technique is applicable to the correction of partial ptosis. There should be no deformity if the incision for the resection of the tarsus is kept at least 3 millimeters and even 4 millimeters from the edge of the lid margin. In case this much tarsus is removed, the levator and smooth muscle should not be advanced into the pocket between the tarsus and skin; the possibility of everting the line of lashes by the pull of the muscles should be avoided. The best plan is to have the lifting effect distributed to the skin and to the tarsus.

5. *The transplantation of the superior rectus.* The credit for the principle of the elevating power of the superior rectus in the correction of ptosis goes to Motala (4, 15) although the names of

Purmand and others are associated with it. The direct indication for the use of this procedure exists when in a case of ptosis the palpebral fissure is actually narrower on up-ward than on down-ward gaze.

The results when this principle is employed are as satisfactory as can be expected in the face of the lack of any other elevating power of the lid. The criticisms are (1) If a narrow central tongue of muscle is attached to the upper lid, an angulation or notching will result. The use of two lateral strips of muscle from the superior rectus instead of the one central tongue has been thought of but has not been used because of the weakening of the elevator action of the globe. Care must be exercised not to produce hypotropia. The author has found that the effect of angulation of the lid may be removed by a differential or graduated tarsectomy after the result is apparent and healing is complete, and that it may in some cases also be prevented by tarsectomy at the time of the original operation. (2) If the full width of the superior rectus is attached to the lid without severing the attachment of the tendon to the globe, an unsatisfactory, inflexible symblepharon usually with entropion and distichiasis results. (3) The weakening of the superior rectus results in diplopia. This is true if the muscle is weakened too much. But if the dissection of the central tongue of muscle is accurate and confined to the central third, there will be

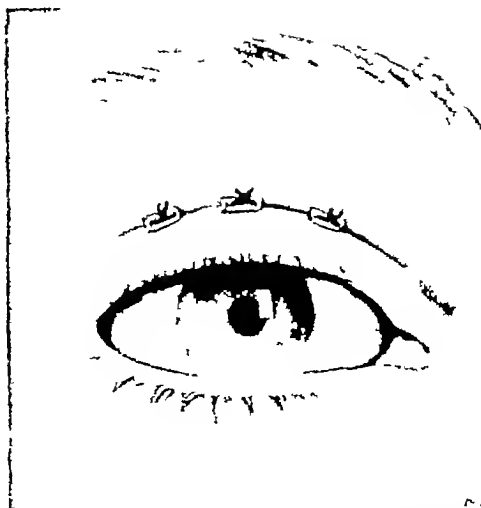


Fig. 16. The catgut sutures are tied and buried on the anterior face of the tarsus. The silk sutures are brought through the skin and after they have pierced the rubber plates they are tied as shown.

diplopia only in the field of special action of the superior rectus. This does not prove annoying to the patient. (4) The union of the globe and the lid through the superior rectus, even though a narrow extensible tongue of muscle be employed, disturbs the co-ordination of the act of closure of the lids. The globe is prevented from rolling up normally and an effort must be made with the orbicularis to effect the closure which normally should occur through relaxation of the elevators. Thus it is observed that the palpebral fissure remains partially open during sleep and is wider on down-ward gaze than that of the fellow eye. No harm results from this slight exposure if the corner is normal. These difficulties are real and not imaginary and cannot be overlooked but they are compensated for by the evident satisfactory elevation of the lid. It is true that the patient cannot elevate the lid independently of the globe, but the lid follows the globe in elevation very naturally and the expression of the eye is good. The innervation, origin and course of the muscle fibers of the levator and superior rectus are the same so that no re-education is required for the new function of the muscle.

Technique of superior rectus transfer.

The original Motz operation was performed entirely through the conjunctiva. The dissection

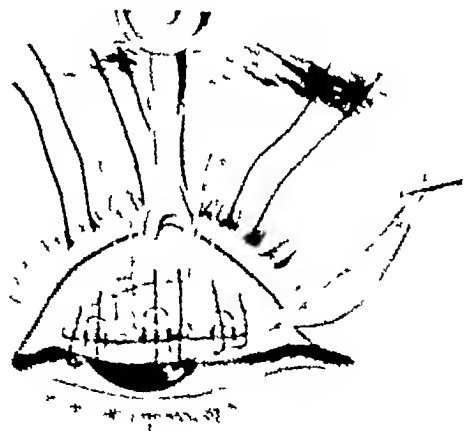




Fig. 7. left. Ptosis of left upper lid and considerable excess of skin of both upper lids.

Fig. 8. Result after resection of levator and smooth muscle. The redundant skin of the lids was unattached.



Fig. 9. left. Ptosis developing after chalazion operation. Resection and re-attachment of levator and smooth muscle of the lid indicated.

Fig. 10. Result after resection and re-attachment of levator and smooth muscle of the lid.

recognized this difficulty and published a report of some cases in which he combined the ease of finding the superior rectus and the shaping of the central tongue of the muscle through a conjunctival incision with the accuracy of suturing the tongue to the tarsus through a skin incision. The method of Shoemaker has been followed with success by a number of surgeons in this country. It was while teaching the Shoemaker procedure on the cadaver in 1917 that the author (13) discovered he could do the entire operation through the skin. This method eliminated the conjunctival incision and sutures and the necessity for removing them. It simplified the operation by reducing the number of steps even though it made the dissection more difficult. The matter of locating the superior rectus through a skin incision is decidedly more difficult than it is through a conjunctival incision but it is much more interesting and instructive. More than 10 years after publication of the technique, the author has had no occasion to change the essential original technique and uses it whenever it is desirable to employ a central tongue of muscle from the superior rectus.

The technique as described in 1928 is as follows. Local or general anesthesia may be used. A horizontal incision 25 millimeters long is made through the skin and orbicularis to the tarsus 8 millimeters above the lid margin. The aponeurosis of the levator is followed backward to 8 millimeters above the tarsal border. Here a horizontal incision is made through the levator and smooth muscle of the upper lid exposing Tenon's capsule. The conjunctiva of the fornix is held down out of the way by a retraction suture. An opening is made

in Tenon's capsule at the temporal side of the superior rectus muscle and a hook is slipped beneath the muscle. The latter is exposed so that a tongue of muscle and tendon 4 millimeters wide by 10 millimeters long can be fashioned. De Wecker scissors are suitable for this purpose. A double armed silk suture is passed through 2 millimeters from the end of the tongue of muscle and tendon. The muscle slip is transplanted to a pouch which is prepared for it anterior to the tarsus. The needles are passed downward piercing the lid margin just nasal to the center of the corner and the suture is tied drawing the muscle tongue and lifting the lid to the position which is required to get the desired effect.

A second suture is used to support the first and to secure accurate and firm apposition to the tarsus. The levator is not necessarily reunited. Excess tissue may be resected. The skin below the incision should be smoothed out in the tarsus and sutured to the epitarsal tissue to help produce a crease or fold. The skin incision is closed by interrupted sutures and a protective dressing is applied. Sutures are removed in 5 to 7 days.

The dressing to be applied is very important in order to protect the exposed cornea. The conical shaped dressing of Wheeler is excellent for the purpose. It is described as follows:

Injury to the partially exposed cornea after operation must be avoided. The dressing should be such that the cornea is properly protected. For several years I have used special dressing on account of lachrymation after the Mott type of operation, and this dressing can be recommended. A thin layer of absorbent cotton is dipped in vasoline and then pressed almost dry between the palms of the hands. This is shaped to make a small cone

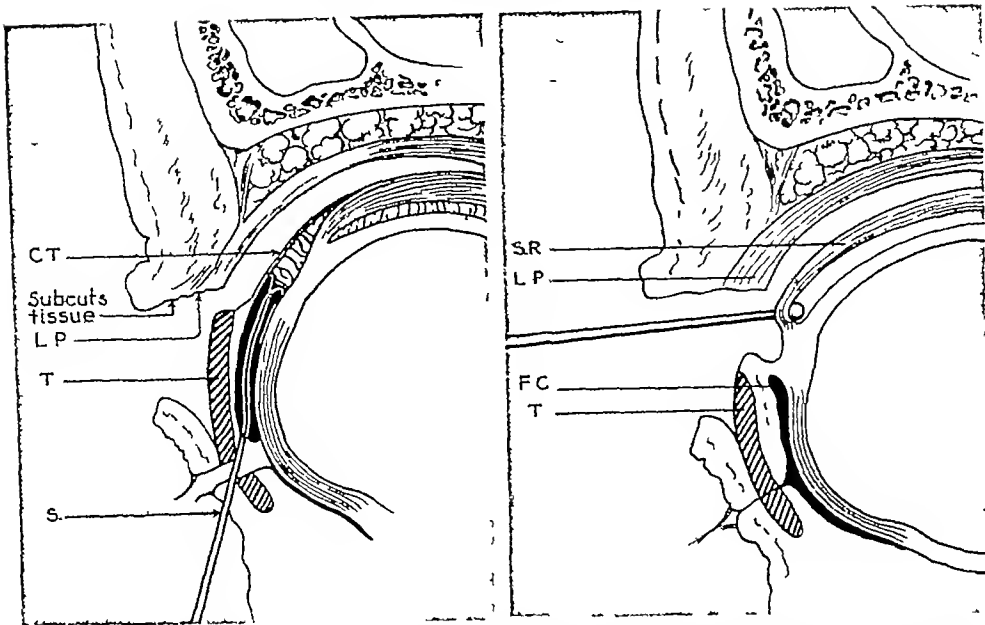


Fig 21 Schematic drawing of surgical anatomy involved in the dissection and isolation of the superior rectus muscle. *C T*, Tenon's capsule, *L P*, levator palpebrae superioris, *T*, tarsus, *S*, sutures used to retract conjunctiva at fornix and to hold eyeball down, *F C*, fornix of the conjunctival sac. *S.R.*, Superior rectus muscle, *L.P.*, levator palpebrae superioris

with the base large enough to cover the base of the orbit. The cone is filled with sterile petrolatum and placed over the eye and lids. Then another layer of moist cotton is placed over the cone with the overlapping joint in a position not corresponding with that of the first layer of the cone. Still a third thin layer is put over the cone. Strips of adhesive plaster are built up from the base to the apex of the cone, to hold it in place and to strengthen it. Even if a child should lie on such a dressing, it is secure enough protection so that nothing but petrolatum could touch the eye. This should be left on for about a week. After it is removed, petrolatum should be put in the palpebral fissure before the patient goes to sleep, as long as lagophthalmos persists."

A shield resting on the margin of the orbit may be used for the same purpose. Frost devised a suture which is double armed. He passes the needles through a small rubber plate, fashioned from narrow rubber tubing, then up to the skin of the upper lid just below the brow hairs, and ties the suture over a rubber plate. This draws the lower lid up to cover the globe but not sufficiently well to permit a tight or semi-pressure dressing. It would be desirable to use a firm dressing if the globe were properly protected to prevent postoperative reaction but this is not a safe procedure.

Postoperative course The dressing is removed after 2 or 3 days. In the case of children, there may be considerable crying and squeezing of the lids. This will put the strength and union of the

tongue of muscle transplanted to the lid to a severe test. If it holds, all well and good. If it does not or if it appears that the tongue of muscle has pulled away from the lid, it is best to face the situation immediately and to locate the muscle and resuture it. The incisions separate easily by blunt dissection and in the 3 cases in which the author has found it necessary to do this, good results were obtained from resuturing.

The efforts to prevent the angulation of the upper lid by the central tongue include the use of 2 lateral tongues, the broad union of the Parinaud-Young operation (28) through the use of which a number of men have obtained successful results, the union of the levator and superior rectus as by Wiener, the Wheeler (25) union of orbicularis strips and levator, the use of fascia lata sling as by Dickey, and the tarsal sling of Trainor. The author would not favor the burial of conjunctival epithelium as in the last procedure nor would he introduce fascia lata. The use of two lateral tongues of superior rectus muscle would hinder the elevation of the globe too much. Hence there are only the procedures of Wheeler and Wiener to choose from, as some intermediary tissue placed between the lid and globe is necessary to prevent the undesirable effects of the Parinaud-Young symblepharon. The author has not decided

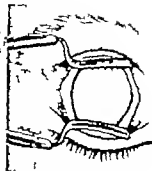


Fig. 22

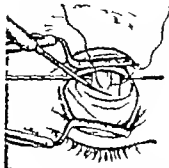


Fig. 23

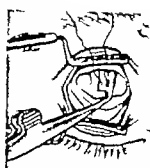


Fig. 24



Fig. 25

Fig. 22. The skin incision has been made and speculum inserted. The tarsus and levator muscles are exposed. The broken line indicates the path of further dissection.

Fig. 23. The superior rectus has been isolated on straight probe. The levator smooth muscle, and Tenon capsule are seen in successive layers. The double armed suture has been inserted and the fashioning of the muscle tongue has been started.

Fig. 24. The fashioning of the muscle tongue completed by incisions with DeWecker's scissors.

Fig. 25. The arrangement of sutures. The muscle tongue is transplanted to the anterior face of the tarsus, its position is secured by the double armed suture and by the transverse accessory suture. The two critical double armed sutures prevent the falling of the lowered skin over the lashes and help in the formation of the crease in the lid.

whether he favors the Wiener or Wheeler method and is subjecting them to further trial.

7. *The technique of the Wiener method.* This method is as follows: The tarsus is exposed by a incision through skin and orbicularis. The levator is isolated between two hooks. Two sutures are placed in the levator near the tarsus. The levator is then cut free. A pocket is made through the levator above the upper border of the tarsus and through the conjunctiva into the upper cul-de-sac. A speculum is introduced into the palpebral fissure and the conjunctiva is dissected to expose the superior rectus. The two sutures are then brought down through the dissection and one is attached to each side of the superior rectus tendon 5 millimeters back of the insertion.

The author has used the principle of this operation but modifies it by a folding the conjunctival incision, dissection, and sutures by the simpler method of using the skin incision and by performing the entire operation through the skin.

8. *H. Keeler's method is as follows (25).* Avertin with the injection of procaine hydrochloride works well. The subcutaneous infiltration near the margin of the lid helps in the dissection because it magnifies the rather thin layer of the orbicularis muscle overlying the tarsus.

The dissection and exposure of the superior rectus through the skin is exactly the same as the author (13) described in 1928. Wheeler continues by dissecting strips of orbicularis muscle from the surface of the tarsus. They are set free at the ends toward the canthi but are left attached at the ends toward the center of the lid. The attached ends are about 8 millimeters apart, and the orbicularis muscle between is undisturbed. Each strip is about 1 millimeter long and 4 millimeters wide. The strips of orbicularis muscle are attached to the upper surface of the superior rectus muscle with No. 000 chromic catgut. It is well for each strip to be attached by means of two sutures, as the strips have to carry a heavy load during the healing process when the upper lid is swollen.

An ordinary probe passed between the superior rectus muscle and the sclera and allowed to project out of the dissected area on each side is useful in steadying the globe in depression while the strips of orbicularis muscle are being attached. After the orbicularis muscle is secured in contact with the superior rectus muscle the only suturing required is that of the skin. This can be closed by several fine silk sutures or by a single subcutaneous suture.



Fig. 26, left Congenital ptosis Resection of levator and smooth muscle of lid indicated

Fig. 27 Notching of lid after correction by transplantation of superior rectus Tarsal resection indicated to correct slight angular deformity



Fig. 28, left Congenital ptosis Palpebral fissure actually narrower on elevation than on depression of the eyes Direct indication for transplantation of the superior rectus.

Fig. 29 Result after transplantation of the superior rectus

THE SURGICAL CORRECTION OF PARALYSIS OF ELEVATION

The problem of the correction of the condition of paralysis of elevation is a most difficult one, inasmuch as the eye is in a position of hypotropia, and if the lid is lifted, the globe will be disclosed to view in this position. The use of the union of the frontalis to the lid has no value for this reason. The globe must first be lifted and with it the lid, or the latter must succeed it in a two stage operation. The logical plan is to be content with the shortening and tensing of the muscle fibers, which may be atrophied, and the fascias of the superior rectus and inferior oblique, and then producing a union between the lid and the globe by a linking to the superior rectus tendon.

Wheeler (25) used this plan on a number of occasions and the author has used it 4 times with as much satisfaction as could be expected. If the fellow eye and upper eyelid are normal, it may be well to be satisfied with the unilateral ptosis because one cannot hope for co-ordination of the eyes. Only for cosmetic effect should the lid be lifted. However, if the patient is dependent on the eye with the ptosis and if the other eye is useless for the same or other reasons, this plan may succeed.

Technique The superior rectus is shortened and advanced as follows. A transverse conjunctival incision is made directly back of the insertion, the muscle is isolated on a hook and then on a multiple-toothed muscle forceps, and the tendon is severed with strabismus scissors from its attachment to the globe. Two double armed

No 0000 10 day chromic catgut sutures are placed 2 millimeters anterior to the insertion and then passed back through the muscle fibers about 8 millimeters behind the cut edge. These sutures are tied and the muscle is resected anterior to the sutures. The conjunctiva is closed with interrupted gut sutures. The inferior oblique is then shortened and advanced according to Wheeler's (24) technique.

"A skin incision about two centimeters long is made along the orbital margin with the anterior attachment of the inferior oblique at about its center. The dissection is carried through the tarso-orbital fascia into the orbit and the inferior oblique is exposed. The dissection is carried also downward for exposure of the periosteum a centimeter or more below the orbital margin. Two fine chromic-gut sutures are passed through the tendon near its anterior attachment, while the muscle is held on a squint hook. The tendon is cut free at its attachment and carried over the orbital margin. It is advanced as much as need be and secured to the periosteum on the facial surface of the superior maxillary bone by means of the gut sutures (000). The skin wound is then closed with fine silk sutures."

The union of the superior rectus to the lid may be effected at the same time as the advancement. The portion of the muscle which is anterior to the suture line on the globe is placed through an incision in the conjunctiva, tunneling anterior to the tarsus and attaching it to the lid as Motais did, or suturing it to the tarsus through a skin incision as Shoemaker did with the central strip of muscle. This procedure seems logical to the author and would be an excellent use for the muscle which otherwise must be cut off and discarded. The lower lid will then be brought up with a suture to protect the globe. The usual way

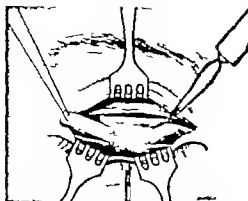


Fig. 30. Wheeler's method of fashioning tongues of muscle from the orbicularis. (Courtesy of *Archives of Ophthalmology*.)

has been to allow the eye to heal after the superior rectus and inferior oblique operation and then secondarily produce the symblepharon in the manner of Parmand or Young.

If the tensing procedures of resection and advancement of the superior rectus and inferior oblique muscle flaps are successful in correcting the hypotropia, it may be unwise to try to support the weight of the lid also by the tension of the inert muscle flaps. The surgeon then may resort to the vicarious action of the frontalis muscle. This would be the only direct indication for employing this principle. The objections to it have been stated, first, that the lid is lifted straight up and, second, that the facial disfigurement of the arching of the brows is continued. The further objections to some of the applications of the principles, namely the burial of foreign material or of epidermis with possible cyst formation, will be overcome if the Reese operation is employed. The technique of this is as follows:

A curvilinear incision is made along the length of the eyelid, 6 millimeters above the center and 4 millimeters above the ends of the margin. Dissection is made beneath the skin 4 millimeters above and 2 millimeters below the incision. The orbicularis is dissected off the tarsus so that two lateral tongues are fashioned the ends are free and the bases are left attached to an area 10 millimeters wide in the center. A double edged knife is used to tunnel the brow from above in front of the tarso-orbital fascia on the sides of the midline and to carry back the sutures which draw up the ends of the orbicularis flaps. A third supporting suture is used centrally. All are tied over small pieces of rolled gauze. The sutures are allowed to remain for 7 days. This operation accomplishes

a union between the lid and orbicularis without the use of foreign material or burial of epibulbar. In these respects it is superior to the other procedures in which the frontalis is utilized. There must, however, be some lagophthalmos the raising of the brows must be continued for elevation of the lids and the lid is lifted straight up and not carried back over the globe.

SUMMARY AND CONCLUSIONS

The condition of blepharoptosis or drooping of the upper eyelid may be corrected surgically. The author favors, first, the improvement of the function of the levator and smooth muscle of the lid in cases in which this is partially preserved. The tarsus and muscles may be resected or the muscles may be advanced for the purpose. The direct indication is present when the ptosis is partial, when there is a partial crease in the skin, and when the palpebral fissure is wider on elevation than on depression of the eyes. Second, the procedure of transplantation of a portion of the function of the superior rectus is employed. The direct indication for this exists when there is practically no function of the levator and smooth muscle of the lid when there is no crease in the skin and when the palpebral fissure is actually narrower on upward than on downward gaze. This phenomenon is produced by the movement of the lower lid associated with the elevation and depression of the globe when the upper lid is practically inert. The principle may be employed even when the superior rectus is paralyzed provided the inferior oblique is active and there is no hypotropia. Third, the condition of paralysis of elevation, which exists when the levator and smooth muscle of the lid in addition to the superior rectus and the inferior oblique are all paralyzed and the globe is in a position of hypotropia, calls for the application of resection and advancement of the superior rectus and inferior oblique coupled with the formation of symblepharon between the superior rectus and the lid, or with the final elevation of the lid by the vicarious use of the frontalis muscle after the globe has been lifted from its position of hypotropia.

The techniques favored by the author for the accomplishment of these principles have been described. The results obtained by operations along these lines are as satisfactory as may be expected. The desired effects are the elevation of the lid without lagophthalmos, the removal of the peculiar facies of ptosis, the creation of a crease in the skin of the lid, and the rolling of the lid in elevation over the convexity of the globe rather than in a vertical plane.

The fact that such a multiplicity of operations have been devised and that such a large number of names have been attached to the various procedures indicates that practically each surgeon who operates for ptosis has developed a new method of his own design or variation, and that even in the hands of the most skillful surgeon, the results are not always entirely satisfactory. Every effort has been made in this paper to simplify the exposition of the principles of blepharoptosis surgery and to advocate only those which give results and which are as satisfactory as may be expected under the conditions present.

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OPERATIVE RESULTS IN DETACHMENT OF THE RETINA AT WASHINGTON UNIVERSITY SCHOOL OF MEDICINE 1934-1938

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St. Louis, Missouri

DURING the 5 year period from January 1, 1934, to January 1, 1939, a total of 113 patients with the diagnosis of detachment of the retina were admitted to the service of the Department of Ophthalmology of the Washington University Medical School. One hundred and nine of them were admitted to Barnes Hospital and the 4 remaining to Saint Louis Children's Hospital. A total of 96 eyes, on which an operation for detachment of the retina was done, is analyzed in this series, as no operation was done on 19 of these patients and 3 had bilateral operations. Previous to this period the operative technique was not standardized well enough for fair comparison, and sufficient time is allowed for a reasonable follow-up of the most recent cases.

This series consists of 73 private cases from all walks of life, with the 31 remaining from the out patient clinic. As shown in Table I the ages vary from 8 to 74 years. The majority of patients were middle aged. Although 77 per cent of the patients were operated upon by 4 surgeons, a total of 3 different operators is represented. Eight operations were performed by the house staff. As this series represents the operative results of a large number of surgeons of varying degrees of skill and experience, in a group of patients of all ages and types, with many variations of detachments, it is an extremely fair test of the effectiveness of surgical treatment of detached retina.

Although there is some difference of opinion as to what constitutes a successful operation for retinal detachment, we believe that only those cases showing a complete anatomical re-attachment should be considered surgical successes. Even in the objectively cured case good central vision is not obtained often because of macular degeneration, but these cases must be considered surgically successful as the object of the operation in re-attaching the retina is obtained. On the other

hand, all those cases without complete anatomical re-attachment must be classed as surgical failures. In the great majority of cases, there is no middle ground; the case is either success or a failure, depending on the presence or absence of complete re-attachment. Partial surgical successes such as incomplete re-attachment, decrease in elevation of the detachment, and improved vision or field without re-attachment are better classed as failures, as the object of the operation has not been obtained, and in time most of these cases will go on to complete detachment. Although the percentage of failures will increase by adhering to these standards, the success in various series may be more easily compared, because they eliminate the term, partial success, which varies with every author.

Because of the well known tendency to re-detachment, a case should be followed for a year, as have most of the cases in our series, before it can be considered a definite surgical cure. Practically none of the cases that are not flat within a few days after the operation will go on to re-attachment, but in our series there is a single patient who, after 3 apparently unsuccessful operations, returned in 8 months with a complete re-attachment and approximately full field.

In accordance with these standards of complete re-attachment with adequate follow-up, a total of 40 cases or 42 per cent of this series are judged to be surgical successes. If we eliminate the obviously unfavorable cases in which operation was done as a last resort with little hope of success, we find that we have to consider a total of 61 cases of simple, uncomplicated, unilateral detachment. In this group 33 cases or 54 per cent were successful.

In the 35 remaining cases which were considered to be unfavorable, only 7 or 20 per cent were successful. As is usually the case, no re-attachment occurred in the 9 aphakic cases, 5 of which followed intracapsular extraction, followed by extracapsular extraction, and were in congenital cases which had had dissections. Although this group is small, it seems to give some weight to the statement sometimes heard that detachment is more common following intracapsular extrac-

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Presented in the Symposium on Ophthalmology before the Clinical Congress of the American College of Surgeons, Philadelphia, October 6-10, 1939.

TABLE I —AGE INCIDENCE

Age—years	No of cases	No of successes
Under 10	1	0
11-19	12	6
20-29	7	1
30-39	12	6
40-49	15	7
50-59	24	10
60-69	17	9
70-79	6	1

tion No successes occurred in the 3 postinflammatory cases which had had uveitis, or in the 3 patients in whom the detachment had been present 2 or more years. It is obvious that these cases should be considered as unfavorable. The 9 bilateral cases are included in this group, as it is evident that there is either a general condition, or some bilateral local defect present which might tend to hinder re-attachment. Five of these bilateral cases or 45 per cent were successful. Even before this series was collected, it was observed that many patients with detachment were blind in the fellow eye from some apparently unrelated cause. In this series this is true in 9 cases or 10 per cent, which seems to be too large a percentage to be accounted for by mere coincidence. Just what mechanism is responsible is not known, but we believe these are justifiably placed in the unfavorable group. In 4 of these cases the fellow eye was blind from previous trauma, and in 5 from inactive inflammations. Only 2 of this group or 22 per cent were successful (Table II).

From the standpoint of the patient, the subjective estimate of visual acuity is a much better criterion of success than the objective, anatomical re-attachment. Of the 40 patients with complete re-attachment 10 or 25 per cent had an excellent result with an acuity of 20/30 or better, 16 or 40 per cent had a good result with acuity of 20/40 to 20/70, and in 14 or 35 per cent only a fair result was obtained, the vision being 20/100 to 10/200 (Table III).

Retinal tears were noted in 57 per cent of the cases with 45 per cent of success, while there was

TABLE II

	Cases	Per cent
Favorable	61	
Successes	33	54
Unfavorable	35	
Successes	7	20
	Cases	Successes
Aphacic	9	0
Postinflammatory	3	0
Over 2 years old	3	0
Bilateral	11	5
Complicated (fellow eye blind)	9	2
	35	7

TABLE III —VISUAL RESULTS IN 40 SUCCESSFUL CASES

Vision	No of cases	Per cent of total success
Fair	20/200 to 10/200	14 35
Good	20/70 to 20/40	16 40
Excellent	20/30 and better	10 25

only 37 per cent of success in the 43 per cent remaining in which no tear was noted. The incidence of myopia was less in this series than usually reported in the literature. Myopia of a significant amount of 2 diopters or more was present in only 18 per cent of this series with 35 per cent successfully re-attached. There was a history of definite trauma in 21 per cent of the cases, and, after eliminating the unfavorable in this group, 11 cases or 69 per cent were successes. The trauma is not necessarily directly to the eye, many followed blows on the side or back of the head, and 2 were associated with dental work in which hammering was done. There is often a definite interval of several weeks between the trauma and onset of symptoms, the tear probably occurs at the time of the trauma and the actual detachment takes some time to form.

It was surprising that in only 6 patients the detachment was chiefly in the nasal quadrant, the 90 remaining were equally divided between superior, inferior, and temporal quadrants. It is significant in the matter of prognosis, that in 73 cases with less than half of the retina detached, 48 per cent were successful, while in the 23 remaining with more than half detached, only 22 per cent were successes.

In 19 of the patients operation was done within 1 week of onset with 54 per cent of cures. In 38 cases the interval between onset and operation was from 1 week to 1 month with 40 per cent of successes. Thirty nine per cent of cures was obtained in the 28 patients with detached retinas 1 to 6 months before operation. Eight cases with 37 per cent successes were detached for 6 months to a year, and in 5 cases with 20 per cent of success, the retina had been detached over 1 year.

TABLE IV —NUMBER OF OPERATIONS PER PATIENT

No of operations	No of cases	Successes	Per cent success
1	56	31	57
2	27	6	22
3	9	2	22
4	2	1	50
5	1	0	0
6	1	0	0

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This series consists of 73 private cases from all walks of life, with the 21 remaining from the out patient clinic. As shown in Table I the ages vary from 8 to 74 years. The majority of patients were middle aged. Although 77 per cent of the patients were operated upon by 4 surgeons, a total of 3 different operators is represented. Eight operations were performed by the house staff. As this series represents the operative results of a large number of surgeons of varying degrees of skill and experience, in a group of patients of all ages and types, with many variations of detachments, it is an extremely fair test of the effectiveness of surgical treatment of detached retina.

Although there is some difference of opinion as to what constitutes a successful operation for retinal detachment, we believe that only those cases showing a complete anatomical re-attachment should be considered surgical successes. Even in the objectively cured case good central vision is not obtained often because of macular degeneration, but these cases must be considered surgically successful as the object of the operation in re-attaching the retina is obtained. On the other

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Because of the well known tendency to re-detachment, a case should be followed for a year as long as most of the cases in our series, before it can be considered definite surgical cure. Practically none of the cases that are not flat within a few days (ter the operation will go on to re-attachment, but in our series there is single patient who after 3 apparently unsuccessful operations, returned in 8 months with a complete re-attachment and approximately full field.

In accordance with these standards of complete re-attachment with adequate follow-up, a total of 40 cases or 41 per cent of this series are judged to be surgical successes. If we eliminate the obviously unfavorable cases in which operation was done as a last resort with little hope of success, we find that we have to consider a total of 61 cases of simple, uncomplicated, unilateral detachment. In this group 33 cases or 54 per cent were successful.

In the 35 remaining cases which were considered to be unfavorable only 7 or 20 per cent were successful. As is usually the case no re-attachment occurred in the 9 aphakic cases, 5 of which followed intracapsular extraction, followed extracapsular extraction, and 2 were in congenital cases which had had dissections. Although this group is small it seems to give some weight to the statement sometimes heard that detachment is more common following intracapsular extrac-

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It is planned to do the next group of thermophore cases with a temperature of 145 to 150 degrees

In conclusion, the operative results in this series are very similar to some previously reported (1), with roughly half of the patients operated on for detachment of the retina obtaining a cure, and approximately two-thirds of these regaining good vision. Multiple scleral diathermy is the most popular operative procedure, but scleral application of the thermophore is a simple and effective method of treatment for retinal detachment. More

general use of the thermophore in detachment would add much knowledge to a method which gives promise of being of real value

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before operation was done. Prompt operation is important not only from the standpoint of a better chance for re-attachment, but even more so in the matter of retaining good visual acuity. In 18 of the 26 cases having a vision of 20/70 or better the operation was done in the first month.

In this series 40 or 42 per cent of the patients had more than 1 operation. Of the patients having a single procedure 57 per cent were successful. Twenty seven patients had 2 operations with 22 per cent success. Three operations were done on 9 patients with 22 per cent success, and had 4 operations with only 1 success. One patient had 5 operations, another 6 but neither was successful. These were desperate one-eyed cases. After each failure the chance for successful future attempts seems less, probably not only from changes caused by the operative procedure, but also by elimination of the favorable cases (Table IV).

A total of 156 operations were performed in this series. The object of all of them was to cause an adhesive chorioretinitis with subsequent re-attachment of the retina. The majority of them were multiple diathermy punctures of the sclera. A Walker ophthalmic diathermy unit with several types of electrodes was used. In 93 cases, the barrage of scleral diathermy was laid down by multiple puncture with a single electrode, the Gräfe Lacrriere, or single straight platinum needle was used. Twenty four of the earlier cases were done with Walker pins. Later this method was abandoned because of difficulty in the handling and application of the multiple pins. In combination with diathermy galvnic current was used in 11 cases in an attempt to seal off the tear. In 23 cases, heat was applied to the sclera by means of the Shahan thermophore. A combination of scleral diathermy and the thermophore was used in 3 cases. A single Guist operation was done unsuccessfully on 1 patient after 4 scleral diathermy operations had been done previously (Table V).

The scleral diathermy procedures are so well standardized that they need no description here. The use of the Shahan thermophore in retinal detachment, which was first reported by Langdon, is not so well known, but also has been described

by one of us (L.T.P.) when 6 of these ones in which the thermophore was used, were previously reported (3). First, the sclera is exposed as is done in the diathermy operations and one or more posterior sclerotomys done. Pains are taken to remove the subretinal fluid by aspiration if necessary. The thermophore is then applied to the bare sclera for 1 minute at 158 degrees. With a 3 millimeter contact surface about 8 to 12 applications are made in the form of a barrage around and over the tear if present. The chief difficulty is application to the posterior portion of the sclera behind the equator. The senior author has devised a curved contact point for use posteriorly. There is probably some advantage in doing the sclerotomys first as this puts the retina and choroid in closer approximation without danger to the retina, and there is no penetration of the sclera. This also aids in the posterior applications, as the globe is more compressible. The thermophore can be applied through the intact conjunctiva, but this seems definitely less effective.

It is extremely difficult to evaluate the effectiveness of the various types of operative procedures as the cases vary so much in type, extent, duration, and complications. In the first place only favorable cases should be used for comparison, second, only the first operation on each case should be considered and finally the techniques should be as near standard as possible. With this in mind, we have figured the percentage of successes of the original operation in favorable cases for each of the operations used, as shown in Table VI. From this the thermophore seems to be the most effective although the total number of cases is not large. It is possible that this method was used in the ideal cases and the diathermy operation reserved for cases in which there was any doubt as to method. Several of the thermophore cases showed large retinal and preretinal hemorrhages, although none of these caused permanent damage. Because of hemorrhage there has been some dissatisfaction with the present technique. It is probable that a lower temperature might be just as effective with less tendency toward hemorrhage.

TABLE V—TYPE OF OPERATIONS

Operation	No.	Successes
Multiple scleral diathermy	94	24
Scleral diathermy Walker pins	24	5
Scleral diathermy with galvanic in area of tear		
Thermophore to sclera	3	8
Thermophore and diathermy	3	
Guist operation	—	—
Total	96	40

TABLE VI.—SUCCESS OF ORIGINAL OPERATION IN FAVORABLE CASES

Operation	Total cases	Successes	Per cent successful
Multiple scleral diathermy	37	3	25
Scleral diathermy using Walker pins	14	6	43
Scleral diathermy with galvanic current	8		
Thermophore	9	7	78
Thermophore and scleral diathermy			

It is planned to do the next group of thermophore cases with a temperature of 145 to 150 degrees

In conclusion, the operative results in this series are very similar to some previously reported (1), with roughly half of the patients operated on for detachment of the retina obtaining a cure, and approximately two-thirds of these regaining good vision. Multiple scleral diathermy is the most popular operative procedure, but scleral application of the thermophore is a simple and effective method of treatment for retinal detachment. More

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LATE RESULTS OF OPERATIONS FOR SEPARATION OF THE RETINA

Report of 304 Operations Performed at the New York Eye and Ear Infirmary from 1929-1938

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A COMPARISON of surgical results obtained in cases of separation of the retina can be only suggestive, for the cause of the detachment, the length of time from the development of the detachment to operation, and the condition of the retina and of the eyes vary markedly among individuals. However the attempt by the American College of Surgeons to evaluate surgical results 9 months after operation should help to crystallize our ideas concerning the value of the various techniques. Moreover these data should provide ophthalmologists with a clearer conception of what may be expected in regard to percentage of cures obtained at a later postoperative date than can be learned from available figures. In comparing the results obtained in this series of cases with those reported by other surgeons, the fact should be kept constantly in mind that these are unselected cases which had been observed for 9 months because in many of the early reports no postoperative time limit was set for publication of results.

A total of 304 operations have been performed upon 230 eyes of 124 patients at the New York Eye and Ear Infirmary. In analyzing the records of these patients, we have encountered the same difficulty that has been observed in previous studies (6) namely that complete medical histories, routine, general, and eye examinations are rarely recorded in the average eye clinic.

Of the 124 cases, there were 13 detachments in the left eye, 107 detachments in the right eye, and 14 in both eyes. Of the 14 patients with separation in both eyes, 6 were operated upon in both eyes.

The following surgeons assisted personnel to include their cases: Francis W. Skene, Bernard Sarnicola, Clyde E. McDermald, Ben Witt Key, Loren Gay Brittan, F. Payson, Thomas L. Boyce, Wendell Hughes, Samuel P. Ouse, William R. Koushner, Wade W. Weeks, and William H. Delaney.

This study has been aided by a grant from the Ophthalmological Foundation, Inc.

Presented at the Symposium on Ophthalmology before the Clinical Congress of the American College of Surgeons, Philadelphia, October 16-20, 1939.

The results were classified under the amount of re-attachment of the retina, visual acuity and visual field. The cases in which there was no complete final postoperative report after 9 months were included if the pre-operative data were complete. In most of these cases there were pertinent postoperative findings, for example in regard to visual fields.

Influence of age and sex. Of the 124 patients, 142 or 63 per cent were males ranging in age from 5 to 80. 82 or 37 per cent were females with an age range of 10 to 74 years (Table I). In this series of cases males were more often affected.

In the 150 cases reported by Dunnington and Macneil, 64 per cent were males and 36 per cent were females. In Shapland's series (1) of 425 cases, 61.2 per cent were males and 38.8 per cent females.

It will be noted that the number of males is higher than the number of females in the patients studied by Dunnington and Macneil, Shapland, and by us. The fact that the eyes of men are more frequently exposed to injury than the eyes of women may account in part for the higher incidence of detachment of the retina among males.

A maximum number of separations occurred within age ranges of 45 to 49 years and 55 to 59 years in the males and of 50 to 59 in the females. The average age of the male group was 56 and that of the female group 38. The average age of both groups was 36.5 years.

Shapland (30) reported that the average age of 140 patients was 43.9 years. In Dunnington and Macneil's series the average age was 39.8 years. Between 20 and 60 years of age there was no material difference in the number of cases they encountered. Spratt has stated that detachment generally occurs in persons over 40 years of age.

The average age in our series is slightly lower than that in the cases reported by Shapland, Dunnington and Macneil, and Spratt. However the average ages of the 4 groups occur between 36 and 43 years.

TABLE I — DISTRIBUTION OF AGE AT FIRST EXAMINATION OF 224 PATIENTS WITH DETACHMENT OF THE RETINA

Age—Years	No of males	No of females
75-80	1	—
70-74	—	1
65-69	4	3
60-64	15	9
55-59	20	7
50-54	11	17
45-49	19	6
40-44	11	10
35-39	14	9
30-34	6	6
25-29	10	6
20-24	14	3
15-19	8	2
10-14	4	2
5-9	1	—
Unknown	4	1
Totals	142	82

The average age according to the result of operation is 40 years in the complete re-attachment group, 38 years in the partial re-attachment group, 33 in the complete detachment group, and 46 years in those cases obtaining no improvement (Table II). In Shapland's (19) report of 100 cases of separated retina, the average age of the cured cases was 34.4 years which was 7 years younger than the average age of the whole group. In our series the average age of the complete re-attachment group was 40 years which was 4 years older than the age of the entire group. Because the age distribution, when results of operation are considered, is so variable no definite correlation can be shown. These findings suggest that in this series of cases age has no bearing on the result of operation. However, advancing age may be a factor in the development of separations. Degenerative retinal changes on a circulatory and toxic basis are considered as important probable causes.

Race Only 2 colored persons were included in this group. This is possibly explained by the fact that the number of colored patients admitted to the New York Eye and Ear Infirmary is small.

Personal history There was an actual relationship between the patient's occupation and the detachment in 19 males and a probable relationship in 1 other. In these patients the detachment occurred following an injury while carrying on their trades. In 3 female patients there was an actual relationship between the detachment and occupation. These women were housewives and retinal separation followed trauma associated with their home duties.

Family history Detachment of the retina was recorded in the family history in only 1 case. Al-

TABLE II — AVERAGE AGE ACCORDING TO RESULT OF OPERATION

Result	No of cases	Age—years
Complete re attachment	52	40
Partial re attachment	28	38
No improvement	40	46
Complete detachment	65	33

TABLE III — VISUAL RESULTS

Vision	Complete re-attachment		Partial re attachment	
	No	Per cent	No	Per cent
Improved	37	71	5	18
Unimproved	7	14	16	57
Not reported	8	15	7	25
Totals	52		28	

though tuberculosis and allergy were reported by several patients, there was nothing of particular significance in the family history which could be correlated with retinal separation.

Previous medical history Previous medical history was not recorded in 107 cases and was negative in 17. In the 100 remaining cases there was practically no diagnostic grouping of previous disease, only 1 or 2 cases were classified under the various diseases.

History of present illness Loss of vision was the complaint most frequently recorded. There was a history of trauma in 66 cases or 29 per cent. Of this number complete re-attachment was observed after operation in 17 cases, partial re-attachment in 12, the results were not recorded in 4 cases and in 12 there was no improvement. Complete detachments following operation occurred in 21 cases. Therefore, of 62 patients in whom the results could be ascertained, 53 per cent were unrelieved, while 47 per cent were improved.

Trauma was a definite factor in producing the detachment in 30 per cent of Dunnington and Macne's cases, and was at least a probable factor in an additional 43 per cent. Of the cases with a traumatic history they report that 451 per cent were either cured or improved. These figures are slightly lower than those reported in our series.

It must be remembered that the injury causing the detachment may occur long before separation of the retina is observed. According to Allen it is the general opinion of many ophthalmologists that there are few patients who cannot, if pressed, recall some injury. Walker believes that "a sudden jerk of the eyes, as in fright, would easily whip a retina loose if certain favorable factors were present."

Physical examination Although the physical examination was not recorded routinely in clinical cases, 18 records indicated the presence of infection in the nasal accessory sinuses. This incidence

TABLE IV.—VISUAL RESULTS IN 49 EYES WITH RETINAL SEPARATION IN THE IMPROVED GROUP

Vision	No. of cases	
	Pre-operative	Post-operative
20/5	4	8 (57%)
20/20+		
20/30		
20/40		
20/50	5	2 (7%)
20/60		
20/70		
20/80		
20/90+	7	
20/100		
20/100-		
20/100		
8/100	3	3
6/100		
5/100		
3/100		
1/100		
Fingers at 600		
Fingers at 1 foot		
Fingers at 3 feet		
Fingers in light field		
Fingers	3	
Hand movements		
Hand movements at 6 inches		
Light perception		
T tests	49	49

seems low because in private patients, who are usually studied more carefully for chronic hyperplastic ethmoiditis, a surprisingly large number seemed to be affected with chronic sinusitis; moreover in a majority of cases the involvement seemed to be more extensive on the side of the detachment. Later exacerbations of endophthalmitis and even the development of areas of chorioretinitis in the eye, free from retinal separation, apparently confirm the belief that low grade chronic sinusitis is an important etiological factor in a rather high proportion of these cases. Tonsillectomy had been performed before operation in 6 patients and the tonsils were considered diseased in 7 others. One patient had a chronic infection of the middle ear. Twelve records indicated the presence of serious dental infection.

The Wassermann reaction was positive in only 5 cases and had previously been positive in 5 cases. This incidence of 6.3 per cent is a little high when compared with 5 per cent in the general population () but hardly seems to be an important factor in the etiology of detachment of the retina in our cases.

Urinalysis revealed slight variations from normal in 30 patients. Other physical findings, for example blood chemistry, blood count, Schilling Index, and blood pressure were abnormal in a few instances but in the majority of cases these findings were not recorded.

Vision. Of the cases in which complete reattachment occurred, vision was improved in 37 unimproved in 7 and not reported in 8 (Table III). In the group resulting in partial reattachment, 5 obtained improved vision, while in 16 vision was unimproved, and in 7 visual results were not recorded. These findings indicate that the possibility of improving vision is not great unless reattachment is complete.

In the entire group of 130 eyes, vision was improved in only 49 eyes (Table IV) and unimproved in 107. In 74 eyes there was no record of pre-operative vision. Table IV reveals that normal visual acuity following operation for detachment of the retina occurred in only 8 or 5 per cent of the 130 eyes, and that only 16 eyes or 17 per cent had 20/70 vision or better. Since 8 of the cases had approximately 20/70 vision, it is questionable whether the maculas in these eyes were entirely healthy.

Because these figures are discouraging from the standpoint of the functional result, they should prove an increased stimulus for the study and removal of possible underlying causes. We agree with Weekers and Hublin (30) that the amount of visual recovery depends not upon the extent of reattachment but upon the degenerative changes which have occurred in the retina.

Changes in field of vision. The visual fields in 36 eyes or 16 per cent were improved. Of our entire series, 4 or 10 per cent had improved vision combined with improved visual fields. Because the methods of examining visual fields varied, the data could not be compared accurately. However 9 patients or 4 per cent were reported to have normal visual fields after operation.

In our series the pre-operative defect in the field of vision corresponded approximately with the area of detachment. When reattachment occurred after operation, the field of form was usually greatly improved. However residual defects were generally observed when separation had been present for several months.

Tension. Lowered ocular tension is generally believed to accompany idiopathic retinal detachment. Moreover some ophthalmologists have stated that primary hypotony is a cause of detachment of the retina. However Amster and Schiff Wertheimer believe that most cases of detachment of the retina are not associated with a

TABLE V—EFFECT OF PRE-OPERATIVE APHACIA UPON RESULT

Result	Cases	
	No	Per cent
Complete re attachment	2	18
Partial re attachment	3	27
Complete detachment	6	55
No report	3	
Total	14	

change in ocular tension. This is the finding in our cases, for pre-operative and postoperative tension were normal except in a small number of cases. If a recent retinal detachment is associated with hypertension, a tumor in the choroid should be suspected. Postoperative tension was low in 29 cases, while in 7 tension was high.

Although postoperative hypotension may be caused by the surgical procedures, in many cases the function of the ciliary epithelium might possibly have been influenced by some toxic factor, as evidenced by endophthalmitis often affecting both eyes. Our results suggest that the operation usually has no marked permanent effect upon tension of the eyeball and that extremely low tension suggests a poor prognosis.

Motor anomalies. There seems to be little relation between the surgical results and whether or not the muscles were detached. In some cases there was temporary weakness of the muscles regardless of whether they were detached or stretched. Annoying diplopia was not a factor in our cases.

Refraction. Myopia was present in 68 per cent of the cases. Spratt has stated that 80 per cent of all cases of detachment occur in myopic eyes. In Shapland's (20) series of 140 cases of retinal detachment, 81 had myopia or 62.3 per cent. Dunnington and Macne report an incidence of 61.9 per cent of myopia. The 68 per cent of myopia in our series of retinal detachment seemed to be slightly higher than the 39 per cent occurring in patients admitted to the refraction clinic of the New York Eye and Ear Infirmary during 1938. Therefore, myopia seems to have been a predisposing factor in producing retinal separation in these cases. In patients who obtained complete re attachment after operation, myopia was present in 17 or 33 per cent and hyperopia in 6 or 12 per cent. Of the entire group, hyperopia was present in 23 per cent and emmetropia in 9 per cent.

Cornea. Pre operative corneal pathology was present in 24 cases. Involvement of the cornea before operation apparently had no relation to the detachment except possibly in 2 cases in which keratic precipitates were observed.

Iris and pupil. In 37 patients there was a pre-operative abnormality of the iris or pupil. Of

TABLE VI—RESULTS FOLLOWING OPERATIONS FOR SEPARATION OF THE RETINA IN 185 EYES IN TERMS OF THE AMOUNT OF RE-ATTACHMENT OF RETINA

Results	No		Per cent
Complete re attachment	52	80	28
Partial re attachment	28		15
No improvement	40		22
Complete detachment	65		35
Total	185		100

this group, iridocyclitis had been present in 2, iritis in 3, and uveitis in 6 patients.

Pre-operative choroiditis was recorded in 19 histories and chorioretinitis in 10. In another case iris bombé occurred. In some cases the signs of inflammation and trauma observed were possibly related to the detachment. In many cases of retinal separation the presence of choroiditis and chorioretinitis combined with endophthalmitis and other choroidal lesions are additional evidence indicating the presence of low grade inflammatory lesions.

Lens. In 52 patients there were some opacities in the lenses before operation.

The impression seems to be general that reattachment of the retina rarely occurs in aphacia. Although complete re-attachment occurred in only 2 of the 14 cases of aphacia or 18 per cent (Table V), 5 cases or 45 per cent had some postoperative re-attachment of the retina. This percentage compares rather favorably with the percentage of complete and partial re-attachments obtained in the entire group.

Shapland (22) has reported that of 28 cases of retinal detachment following extracapsular cataract extraction, 3 or 18.75 per cent were cured. In another group of 15 patients with aphacia following retinal detachment observed by Shapland, only 1 had a reposition which lasted for only 9 days.

Because our group of cases is small, a comparison of our results with those of Shapland is difficult but a higher incidence of re attachments seems to have been obtained in the patients operated upon at the New York Eye and Ear Infirmary.

Vitreous. The presence of vitreous opacities was recorded in 113 cases before operation. In 107 there was no record of changes in the vitreous. Dunnington and Macne found pre-operative opacities in practically all their cured and improved cases.

Low grade chronic endophthalmitis was suspected as having existed in a high proportion of our patients. Moreover, clinical experience has proved that both eyes are usually affected. These points are highly suggestive that the possibility

TABLE VII.—A COMPARISON OF RESULTS REPORTED BY VARIOUS SURGEONS

Surgeon	No. of cases	No. of eyes	Post-operative vision	Discharge	Transillumination	Orbit	Glaucoma	Strabismus	Conjunctivitis	Scleritis (Keratitis)	Exophthalmos	Enophthalmos	Choroiditis	Transillumination	Enucleation	Follow-up
Warner	7		7										1/2			
Lawson	40			20											10	100%
Ross and Stephens				20											10	100%
Peter													1/2			100%
Shepherd	146		7		70								1/2	1/2	1/2	100%
Donington & Macleod		12	10		11								1/2	1/2	1/2	100%
Imre	167												1/2	1/2	1/2	100%
Kernach		14	11		13					1			1/2	1/2	1/2	100%
Lachert		10							10				1/2	1/2	1/2	100%
Lazarev	14												1/2	1/2	1/2	100%
Kayser			10										1/2	1/2	1/2	100%
Turton, Ford and Duffie	10		8		10	1/2							1/2	1/2	1/2	100%
Boecklin	100						10						1/2	1/2	1/2	100%
Quarr	200						200						1/2	1/2	1/2	100%
Barnes, Hall, Smith and McAlpine	15		17	14				11					1/2	1/2	1/2	100%
Griffin and Meyer			100%		10			1					1/2	1/2	1/2	100%

*99 Quarr

†15 Quarr group are included 6 multiple perforating puncture combined with iridectomy and 100% transillumination and 100% transillumination

of a low grade chronic inflammation of the tissues of the eye is a predisposing factor to retinal separation in many patients.

Hemorrhage in the vitreous was present before operation in 3 patients. There was a membrane in the vitreous in 1 eye and exudate in another.

Greeves emphasizes the fact that spontaneous vitreous hemorrhage may be caused by retinal detachment. However, none of his patients developed postoperative hemorrhage in the vitreous. When hemorrhages occur the prognosis is apparently good in regard to surgical results.

Optic nerve. Retrobulbar neuritis was present before operation in 4 patients. This does not point to the presence of chronic inflammation.

Transillumination. Transillumination reveals a tumor in our series of

In 1 case, which was later enucleated because of glaucoma and pain, a small sarcoma was found near the posterior pole. In another case which was not included in this series, transillumination was apparently normal but when the operation was commenced a perforating tumor was found.

Gradle and Meyer conclude that if practically all eyes with retinal detachment are operated upon by modern methods, re-attachment will occur in somewhat less than 50 per cent, but if only selected eyes are operated upon, the percentage of re-attachments will be nearer 70.

Cures have been reported in ophthalmic literature in from a third to a half of patients operated upon (Table VII). Therefore, it may be seen that the results following operation for detachment of the retina are markedly different. This is natural considering the varying etiologies, condition of the retinas, and the differing lengths of time after operation when the reports were made. In comparing the results with those of other surgeons, the 9 months' postoperative period of observation in these cases should be considered.

Description of operations employed by surgeons at the New York Eye and Ear Infirmary. In all operations performed by surgeons at the New York Eye and Ear Infirmary, the sclera over the involved area of detachment is exposed, a canthotomy or temporary tenotomy is performed, if necessary. In the last few years, however, fewer muscles have been severed even temporarily.

The following operations which were performed on patients operated upon for detachment of the retina at the New York Eye and Ear Infirmary, have been employed for varying periods of time from 1929 to 1938. However, at the present time, 5 of the 6 senior surgeons use diathermy alone or combined with trephine, and 1 senior surgeon uses electrolysis combined with diathermy.

Gonin operation (cautery puncture). An incision is made close to the area of the tear and an actual cautery tip inserted through the sclera into the vitreous and allowed to remain from 4 to 5 seconds. In some cases the sclera is trephined before the cautery is applied. As many as 3 punctures are made, depending upon the size or number of holes in the retina.

Gust Lindner operation. Chemical cauterization of the choroid is made through a trephine opening in the sclera. Two or 3 trephine openings, 1.5 millimeters, are made in the sclera over the site of the tear and sometimes as many as 15 or more are made over the area of detachment. Potassium hydroxide is applied to the choroid which then is neutralized with a 0.5 per cent solution of acetic acid. The wound is irrigated with physiological saline solution. Subretinal fluid is allowed to escape by perforating one or more of the trephine openings with a blunt probe.

Sellar operation. Using a diathermy current of about 50 milliamperes, small needles about 1.5 millimeters in length are placed over the retinal

tear, then over the entire area of the detachment. After all the needles are placed, they are removed, allowing free escape of subretinal fluid.

Larsson operation. A ball electrode of about 1.5 to 2.5 millimeters in diameter is applied to the sclera for about 5 seconds and electro-endothermy is used. These applications are made at several places a few millimeters apart, no precise localization of the hole is attempted. The subretinal fluid is evacuated by one of the usual methods.

Diathermy with the Lacarrere needle. Numerous diathermy punctures are made with the Lacarrere needle throughout the entire area of detachment. A special attempt is made to exclude or obliterate tears.

Diathermy with Walker pins. Small needles are inserted over the area of detachment, encircling the tear especially. The diathermy current is adjusted so that little pressure is needed when placing the needles. They are allowed to remain *in situ* until all punctures are made.

Electrolysis combined with diathermy. Electrolytic punctures are made over the entire area of detachment and sometimes in the area where the retina is not detached, especially if this area is in the superior quadrants. The first puncture is made in the places where the tear or tears have been localized. The ophthalmoscope is used to control the further application of the needles in the region of the tear by observing the location of the bubbles in relation to the tear. Special care is taken to surround the retinal tears if they are present. Moreover, an attempt is made to wall off a disinsertion at the ora serrata. The punctures are made with straight and angulated Walker iridoplatinum needles especially sharpened, and a 1.5 milliamperage current is used. Diathermy and the Walker bident electrode are then employed to cover the same area in an attempt to shrink the sclera and develop more extensive adhesions between the choroid and retina. Several completely perforating punctures are made around the tear and where drainage will be favored. If the inferior part of the retina is involved, complete perforations are placed on each side of the inferior rectus.

Some surgeons seem to be reverting to the electrolysis operation, proposed originally by Schoeller, in 1880, and also advocated by Verhoeff, in 1917, as one of the best methods of treating these detachments. At the time Verhoeff proposed the use of electrolysis he did not seem to stress the importance of finding and closing the tear.

It is now conceded by most ophthalmologists that the tear must either be closed or surrounded by a water-tight ring of scar tissue. Although

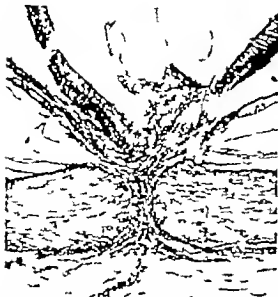


Fig. Episceral proliferation through electrolysis puncture wound in the eye of rabbit. Note firm localized cicatrix present after 8 days.

satisfactory results seem to be increasing in number better methods of producing adhesions between the sclera, retina, and choroid are being sought. It has been demonstrated by Weekers (29) in experiments on rabbits and in one human eye (28) that proliferation of the episceral tissue into the wound makes the firmest adhesion between the three structures (Fig. 1). Proliferation of the episceral tissue is evident 8 days after electrolytic puncture of the sclera in a rabbit's eye. Weekers believes that the episceral process produces more circumscribed but stronger attachments than the choroidal process. The adhesive chorioiditis produced by surface coagulation affects a larger area of the retina, but because the adhesions are not so firm recurrences are more likely to develop.

Weekers further demonstrated that it makes little difference apparently whether a knife, an electrolysis needle, a diathermy needle, or trephine is used as long as the sclera is perforated. This fact probably explains why good results are obtained by so many different methods. The episceral proliferation will penetrate through a fine scleral wound made with a narrow Giesle knife. However diathermy or electrolysis tend to control bleeding and facilitate the proliferation of the episceral connective tissue.

Relation of duration of detachment at the time of first operation to result. These data concerning the

TABLE VIII.—RELATION OF DURATION OF DETACHMENT AT TIME OF FIRST OPERATION TO RESULT

Result	Duration			
	less than 1 month	1 to 3 months	3 months or longer	Total
Complete re-attachment	10	5	5	20
Partial re-attachment	3	0	0	3
Complete detachment	0	1	1	2
No improvement	0	9	4	13
Total	13	15	10	38

relation of duration of detachment to the time of first operation seem to indicate that better results may be expected if the detachment has not persisted more than 1 month. However the figures on complete and partial re-attachment are not sufficiently different to be conclusive evidence (Table VIII).

Weekers and Hulsh (30) state that if re-attachment does not occur the recovery of function depends upon the length of time the detachment has existed and upon the underlying cause of the detachment.

The results obtained by Dunnington and Macnicke were just as good in the cases of over 3 months duration as they were in those of less than 1 month's duration.

According to Ellett and Rytchener cases treated within the first few weeks, rather than months, respond best. In their cases the time of operation varied from 6 days to 6 months following the detachment. Their final results were in agreement with the general belief that early interference usually produces the best results.

However opinions vary concerning the importance of the duration of the detachment. Gräfe and Meyer believe that in the average case the long duration of the detachment, within reason, is not a contra-indication to operation. In our opinion, since the individual case arises from others in many ways, no sweeping conclusion should be drawn.

Extent of pre-operative detachment in relation to the result. The figures for the extent of the pre-operative detachment in relation to the result

TABLE IX.—EXTENT OF PRE-OPERATIVE DETACHMENT IN RELATION TO THE RESULT

Extent	Complete re-attachment	Partial re-attachment	Complete detachment	No improvement
Total	3	3	3	3
Three-quarters	3	7	2	3
One-half	3	3	3	4
One-quarter	3	3	3	4
No report	3	3	3	4
Total cases	5	13	6	17

seem to indicate that the greater the detachment the less likelihood of re-attachment (Table IX). The largest number of complete re-attachments occurred in those cases in which $\frac{1}{2}$ and $\frac{1}{4}$ of the retina had been detached before operation. Of the cases resulting in partial re-attachment the largest number occurred in those in which $\frac{1}{4}$ of the retina had been detached before operation. Of the cases resulting in complete detachment the largest number occurred in those in which the retina had been totally or $\frac{1}{2}$ detached before operation. If detachment is extensive, the operative field must necessarily be larger. According to Gradle and Meyer the extent of the detachment is an important factor in the prognosis.

Relation of original site of detachment to result The site of the original detachment did not seem to influence the final result from the standpoint of re-attachment of the retina (Table X). Dunnigton and Macnie reached this same conclusion.

Relation of tears and disinsertions to result These figures seem to indicate that although tears were found in 67 cases or 29 per cent, their presence was not an important factor in obtaining re-attachment (Table XI).

Multiplicity of tears did not seem to be important in either the re-attachments or complete failures in this series. However, in operations on private patients one of us (C B) has had poorer results in the presence of multiple tears.

In the cases reported by Gradle and Meyer, holes or tears in the retina were discovered in 55.7 per cent. They believe that the hole plays a rôle but how great a rôle is still undetermined.

The necessity of locating and closing retinal holes has been questioned by many ophthalmologists. In 1925, Weekers stated that since holes are not always present, they should not be considered indispensable to the production of detachment.

Ellett and Rychener believe that locating and sealing the tear is important. A contrary opinion is held by Dunnigton and Macnie for in their cases the "blind" operations were almost as successful as those in which holes were located and treatment concentrated around them.

In Shapland's report (20), a retinal hole or holes were found in 80.7 per cent. In his series of cases, disinsertions were multiple in 9.3 per cent and combined with other types of retinal holes in 11.6 per cent. Gradle and Meyer believe that disinsertions must be considered individually for the seriousness of a disinsertion is governed by the extent. They state that if the retina curls back and cannot be brought forward into place, a disinsertion is a contra-indication to operation. The

TABLE X —RELATION OF ORIGINAL SITE OF DETACHMENT TO RESULT

Site	Complete re-attach-ment	Partial re-attach-ment	Complete detach-ment	No improve-ment
Superior nasal quadrant	12	6	16	15
Superior temporal quadrant	19	10	22	20
Inferior nasal quadrant	16	10	22	19
Inferior temporal quadrant	18	9	28	22
Complete	2	1	19	1
No record	15	5	15	6

incidence of disinsertions in our cases was low, only 5 were recorded in the entire series.

The consensus of opinion seems to be divided concerning the importance of finding and sealing tears in relation to the result. In our opinion when a tear is present special effort should be made to close it. Moreover, closure or failure to close these tears or to exclude disinsertions is an important factor in the final results obtained.

Clinical type of retinal detachment in relation to result The records were incomplete for the classification of cases according to the clinical type of retinal detachment. Moreover, they were so contradictory that no useful conclusions could be deduced from these figures in relation to the result (Table XII).

It is reported by Dunnigton and Macnie that in 150 cases most of the detachments were bullous. However, the percentage of cures and improvement was essentially the same for the different clinical types of detachments.

Relation of type of operation to result The low number of Gonin and Guist operations reported in this series of cases indicates that the diathermy operation is the one favored (Table XIII).

The highest percentage, or 23 per cent, of complete and partial re-attachments was recorded following the diathermy operation, the next best

TABLE XI —RELATION OF TEARS AND DISINSERTIONS TO RESULT

Tears and disinsertions	Complete re attach-ment	Partial re-attach-ment	Complete detach-ment	No improve-ment
Tears	14	1	12	7
Angular	1		1	
Irregular or curved	1	1	2	1
Horseshoe	5	1	3	2
V shaped	1		3	
Multiple holes	1	2	1	1
L-shaped	1			
Linear		2	3	
No tear	7	3	13	6
No report	20	18	27	21
Disinsertions	1	2	2	

TABLE XII — NUMBER OF CASES OF EACH TYPE OF RETINAL DETACHMENT IN RELATION TO RESULT

Type	Complete re-attachment	Partial re-attachment	Complete detachment	No improvement	No record
Flat	7		5		
Balloons	3		17		5
Horizontal					
Mixed					4
Seroses					
No record	4	24	40	36	35
Total	3	25	65	40	45

results or 6 per cent were recorded after the trephine operation. However the number of operations in each group is too small to draw definite conclusions (Table XIII).

Relation of result of retinal detachment operation to number of operations performed. From a study of the relation of the result to the number of operations performed, the successes were in indirect proportion to the number of operations required (Table XIV).

Our experience is in accord with Gradle and Meyer's suggestion that a second operation should not be performed too soon after the first. A delayed or slow improvement often occurs in cases in which diathermy is applied and the eye should not be subjected to insult before signs of traumatic inflammation have subsided almost completely.

Operative complications in 224 patients and 193 operations for detachment of the retina. In view of the amount of traumatism which is unavoidable in performing some of these operations, the number of complications during operation seems to be small. Moreover no serious complication was recorded in this series of operations (Table XV).

Postoperative eye complications. Considering the length of time that these patients must remain quiet in bed, frequently with both eyes bandaged, it is surprising that the amount of postoperative delirium is low (Table XVI). The use of sedatives may play an important rôle in the production of

TABLE XIV — RELATION OF RESULT OF RETINAL DETACHMENT OPERATION TO NUMBER OF OPERATIONS PERFORMED

No. of operations	Complete re-attachment	Partial re-attachment	Complete detachment	No improvement	No report
1	67	26	66	20	44
2			26		
3					
4					
5					
6					
7					
8					
9					
10					
Total	58	27	92	22	44

delirium. However in a series of 1,004 cataract operations, delirium occurred in only 2 cases (5).

The only complication which occurred sufficiently frequently to be considered serious was postoperative hemorrhage into the vitreous in 6 cases. This would seem to be a surprisingly low incidence of hemorrhage considering the diseased condition of many of the eyes, the age of the patients, and the degree and extent of insult to the vascular system of the eyes. According to Gradle and Meyer subsequent hemorrhage into the vitreous is still one of the great dangers of operation for retinal detachment. They believe that this danger is less following diathermy operations.

Complications in Shapland's cases (20) were notably small in number. They were occasional small subretinal and intrachoroidal extravasations of blood, secondary rents in 12.5 per cent of the cases, 2 cases of uveitis, 2 of possible localized choroidal infarcts, and 1 of complete vitreous hemorrhage.

Incidence of postoperative cataract compared with result of operation. From clinical observations apparently cataract is more likely to develop if the retina is not re-attached. Although this number of cases is hardly sufficient to present conclusive evidence on this point, the figures suggest that this clinical impression is strengthened by these data. In the complete re-attachment series only 1 cataract developed after operation (Table XVII).

TABLE XIII — RELATION OF OPERATION TO RESULT

Operation	Complete re-attachment	Partial re-attachment	Complete detachment	No improvement	No record
Diathermy	40	30	65	37	33
Diathermy and electrolysis					
Electrolysis					
Gowen	4		7		8
Gust			7		3
Trepheine					
(Thompson)	8		5		4
Not stated			5	3	
Total	58	47	92	45	40

TABLE XV — OPERATIVE COMPLICATIONS IN 224 PATIENTS FOLLOWING OPERATION FOR DETACHMENT OF THE RETINA AT THE NEW YORK EYE AND EAR INFIRMARY

Complications	No. of cases
Low tension of the eyeball	
Loss of vitreous	1
Vitreous hemorrhage	
Hemorrhages in retina	
Hysteria	

TABLE XVI — POSTOPERATIVE EYE COMPLICATIONS

Complication	No of cases
Secondary glaucoma	3
Spontaneous hemorrhage in vitreous	6
Traumatic hemorrhage (after fall)	1
Corneal abrasion	1
Ulcers of cornea	1
Endophthalmitis	4
Iridocyclitis	2
Dislocated lens	2
Retinitis proliferans	1
Iris bombé	1
Degeneration of the retina	1
Hypotony	1
Pain	1
Hemorrhage at site of operation	1
Degeneration of macula	1
Delirium	1
Total	28

Dunnington and Macnie report that no successful case in their series developed clouding of the lens as a postoperative complication. Of the cases in which complete detachment resulted, cataracts developed in 12. Our clinical experience suggests that cataracts eventually develop in all cases of complete detachment and that Table XVII does not give the picture, which would be presented if all the cases of complete detachment were observed after 5 years.

Postoperative general complications. The general complications were varied and few in number (Table XVIII). Apparently they bear little relation to the operation for retinal separation unless possibly the necessary confinement in bed for such a long period of time.

SUMMARY AND CONCLUSIONS

1 From 1929 through 1938 a total of 304 operations were performed upon 230 eyes of 224 patients at the New York Eye and Ear Infirmary. Clinical records are usually incomplete, particularly concerning re examination after 9 months. Therefore, follow-up should be improved.

2 The average age of these patients was 36.5 years. Advancing age seems to play an important role since a maximum number of detachments in the patients operated upon at New York Eye and Ear Infirmary occurred within an age range of 45 to 59 years. No correlation seemed to exist between age of patient and surgical result.

3 There were 142 males and 82 females included in this series. These figures agree with those of other surgeons which indicate that there is a higher incidence of retinal detachment in males. Exposure to traumatism may be a factor.

4 The medical history apparently showed little correlation with the development of retinal separation except possibly in regard to trauma. There was a history of injury in 66 cases or 29 per cent.

TABLE XVII — INCIDENCE OF POSTOPERATIVE CATARACT COMPARED WITH RESULT OF OPERATION

Result	Total no of eyes	No of eyes developing postoperative cataract
Complete re attachment	52	1
Partial re attachment	28	3
No improvement	40	4
Complete detachment	65	12
No report	45	1
Total	230	21

TABLE XVIII — POSTOPERATIVE GENERAL COMPLICATIONS

Complication	No of cases
Large abscess of buttock	1
Acute fibrinous pleuritis	1
Coronary thrombosis	1
Phlebitis of both lower extremities	1
Total	4

There was a history of injury in 66 cases or 29 per cent.

5 The general physical examination revealed unimportant data in these patients except concerning focal infection, especially oral and nasal accessory sinus disease. Sinus infection was usually more active on the side of the retinal separation.

6 Vision was improved 9 months after operation in a low percentage of cases or in only 21 per cent.

7 The 16 per cent of cases in which the field of vision was improved after 9 months is even lower than the number in which vision was improved.

8 In only 24 cases, or 10 per cent, were vision and visual fields improved. These percentages seem quite low.

9 Pre-operative and postoperative tension were normal with the exception of a few cases. Operation for detachment of the retina usually had no marked permanent effect upon tension of the eyeball, extremely low tension apparently suggested a poor prognosis.

10 No definite correlation could be discovered between motor anomalies and the development of the retinal separation. After operation, no serious diplopia was complained of, even though muscles were detached in several cases.

11 Myopia was present in 68 per cent of the cases and hyperopia in 23 per cent. From these data and the figures of others, myopia and trauma seem to be important, predisposing, or exciting factors in development of separation of retina.

12 In only 2 cases in which keratic precipitates were present before operation was there any possible relation between corneal pathology and detachment of the retina.

13. Pre-operative choroiditis occurred in 19 cases, chorioretinitis in 10, and vitreous opacities in 113 cases. A number of cases showed evidence of previous inflammation of the iris and ciliary body. Therefore vitreous opacities and evidence of past inflammation of the uveal tract occurred in a high percentage of eyes before operation. These findings suggest the presence of a low grade inflammatory process as a possible factor in the etiology of retinal separation.

14. In only 5 of the 14 cases in which aphacia existed before operation was there complete or partial re-attachment of the retina. This 45 per cent of improvement is high in the light of our own statistics and those of other surgeons. Therefore these results may indicate that the pessimism concerning separation of the retina associated with aphacia may not always be warranted.

15. Transillumination apparently was normal in the majority of the cases. However sarcoma of the choroid was discovered later in 1 patient and in another operation for detachment of the retina was discontinued because of the discovery of a perforating sarcoma.

16. The operative procedures of 5 senior surgeons at the New York Eye and Ear Infirmary at the present time are limited to diathermy alone or combined with trephine and 1 senior surgeon uses electrolysis combined with diathermy. The majority of the operations performed are variations of the application of diathermy.

17. Complete re-attachment occurred in 5 eyes after operation partial re-attachment in 18 eyes, no improvement in 40 eyes, complete detachment in 65 eyes, and no complete examination after 9 months was recorded in 45 eyes. Therefore complete and partial re-attachment were present after 9 months in 80 of the 85 eyes.

18. The largest number of cases had detachment of the retina for less than 1 month at the time of the first operation and the greatest number of complete and partial re-attachments occurred in this group of eyes. However no valid conclusions can be drawn from the data concerning the duration of the detachment at the time of the first operation and the result since the number of cases with complete and partial re-attachment when the operation was performed after 3 months, was almost as great as the patients operated upon within 1 month.

19. Of the cases with pre-operative total detachment, only 3 were completely re-attached, while 2 of the three-quarter detachments were re-attached. Of the cases in which three-quarters of the retina was separated before operation, partial re-attachment was obtained by only 3. By 7

in which one-half of the retina had been detached, and by 13 of the cases in which one-quarter of the retina had been separated. These statistics indicate that the more extensive the detachment the less likelihood of re-attachment.

20. The site of the detachment was about equally divided among the quadrants in these 230 eyes. The original site of the detachment seemed to bear little relation to the final result of operation.

21. Tears were observed in 67 eyes. The presence or absence of tears apparently bore little relation to the final result but experience in these cases suggests that when tears or disinsertions are present they must be closed or excluded.

22. In the majority of cases some form of diathermy operation was employed. Therefore, no important conclusion can be drawn concerning the comparative value of the different types of operation.

23. The largest number of operations were performed upon the unsuccessful cases. These data suggest that if the first operation is unsuccessful, good results after 9 months from multiple operations are seldom obtained.

24. Operative and postoperative ocular complications occurred in only a few cases and seemed to be unimportant as far as the final result was concerned. The only serious complication was a vitreous hemorrhage in 6 eyes.

25. Postoperative cataract developed rarely when the retina was completely re-attached. This occurred in only 1 of 45 eyes in our series. Eyes with complete detachment of the retina developed cataracts after 9 months in 12 instances. These data seem to substantiate clinical experience which indicates that cataracts eventually develop in all eyes with permanent complete detachment of the retina.

26. From the viewpoint of re-application of the retina, the operative treatment of detachment of the retina seems to be improving. However because late visual and visual field results are often disappointing, more knowledge of the cause and prevention of serious retinal pathology especially in the macular area of the retina is urgently needed.

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REPORT OF OPERATIONS FOR DETACHMENT OF THE RETINA AT THE MAYO CLINIC

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IN the summer of 1930, my associates and I began a series of operations for detachment of the retina, after the method described by Gonin and modified by other surgeons in this country and abroad. Since we had not previously operated for retinal detachment, we had no clinical experience on which to base a selection of suitable patients nor had we any definite plan of postoperative care. Previous to that time we had noted rents in the retina in some instances of detachment, but we had not instituted careful search for rents, tears, or holes in the retina because they held for us only academic interest. It was only after the significance of the rents had again been emphasized by Gonin in reference to surgical treatment that we began to scrutinize them with reference to the sclera. Several methods of localizing retinal tears were published in current journals and some were utilized, while others were found to be too complicated for the added degree of accuracy attained by their use.

The actual cautery was used in 18 operations on 15 patients in the period of 3 years. At the clinic we used Post's electric cautery designed for the purpose, rather than Paquelin's cautery because of the greater care with which the new instrument could be handled. All patients operated on had extensive detachments with rents that were locallizable. Vision, with 3 exceptions, was reduced to perception of moving objects only and since the eyes of these patients were doomed to blindness without treatment, the risk of operation could not be a marked deterrent.

The detachment was recent or within 3 months in 5 cases, the most recent one, 8 days, the most ancient one, 3 years. In 1 case, the retina had been detached only 3 weeks and the vision in the affected eye was 6/10. Six weeks following the operation, the vision was 6/10 and remained at that value with full field of vision and anatomical restoration of the retina for 2 years. The retina then became detached again with vision reduced to 6/100. The eye was operated on by fulguration, but the result was not satisfactory. Some months

later the eye was removed for endophthalmitis. The retinas of 2 other patients became re-attached after performance of a Gonin type of operation but vision, which had not been better than perception of moving objects before operation, was not improved. In other cases, the retina seemed to be satisfactorily restored to its normal position for a few weeks but the vitreous body was hazy as a result of either hemorrhage or reaction to the operation. Recurrence of the detachment was not uncommon. In 6 cases the retina remained detached after the operation. No eyes were lost as a direct result of the cauteryization. Summing up the results of the Gonin type of operation, there were 8 operations on 5 patients with no permanent satisfactory results.

The failures may be attributed to several factors: (1) Most of the instances of detachment were not favorable for a satisfactory outcome. (2) There was complete inability to close the hole in the retina. Failure to find all openings in cases of multiple rents or holes. (3) Hemorrhage at time of operation was often severe and clouded the vitreous. (4) Severe reaction to the operation occurred in some instances with some loss of vitreous followed by very low tension and eventually by phthisis bulbi. (5) Patients were kept in bed only 2 weeks, whereas they should have been kept quiet for a longer time.

At the clinic in the latter part of 1933 we abandoned the Gonin operation and for several months did no operations for retinal detachments. We began to use the Saffar type of operation in February 1933 and employed various modifications during the following years. The results of these operations have on the whole been rather encouraging. While the criterion of success has not been defined, it may be well to state that instances in which our operations have been successful have been so classified on the basis of usual acuity, visual field, and restoration of the retina to its normal position. In all 3 respects, the eye most appear to be as well or better than it was before operation. Ever since we began to employ the fulguration operation our results have been uniform. They are not better for the year 1935 than they were for the years 1933 and 1934. While there have been changes in technique that have

From the Section on Ophthalmology, The Mayo Clinic.
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materially shortened the time required for operation and lessened trauma, only the operation has been simplified

While discussing technique, I might say that as we do the operation now, it requires only 20 to 30 minutes. Briefly stated, the following are the important time saving points (1) General anesthesia is obtained by the intravenous administration of pentothal sodium (2) Tendons of ocular muscles are not divided. They are retracted by hook when necessary (3) The rent or rents previously have been localized accurately (4) A single needle is employed, it is possible with Gradle's needle to reach the globe at any point without difficulty (5) Subretinal fluid is drained after fulguration is complete, an electrically driven trephine is used to make an opening through the sclera 1 millimeter in diameter in the dependent portion of the area of the detachment (6) The patients in whom the retina becomes re-attached are kept in bed with eyes bandaged for 25 to 30 days, at the end of which time pin-hole goggles are worn for another 30 days

Two patients of this latter group had bilateral aphacia. In 1 patient the retina in each eye became detached 3 years following successful intracapsular extraction of cataract done elsewhere. The interval between operations for cataract was 1 year, and between detachment 1 year, in the order of the previous operations. Results of the fulguration operations were satisfactory, resulting in vision of 6/12 in each eye and preservation of

nearly normal visual fields. In 1 other aphacic eye the visual field was restored to nearly normal and the retina was replaced, but the visual acuity was not recorded. The latest available data on 78 operations performed by the fulguration method permit me to list 38 in the successful group and 40 in the unsuccessful group. There were 5 patients for whom the immediate result was satisfactory but whose retinas again became detached within 3 months. These are now listed here as unsuccessful operations. The total count of cases classified as I have reported them here is not truly indicative of the final result of the operation. It may, however, be possible to formulate from a review of these cases a basis on which to select those patients who will have a more favorable prognosis and to evaluate modifications in the technical procedure to be used. As long as surgeons continue to operate for detachment in instances of detachment associated with other major changes such as advanced myopia, diabetes, arteriosclerosis, chorioiditis, multiple retinal tears, and various changes caused by vascular disease, the proportion of successful operations for detachment will remain low.

Judged by the standard of maintenance of previous visual acuity, integrity of visual fields, and re-attachment of the retina for at least 9 months after the operation, our results at The Mayo Clinic with the Gonn method of operating were all failures. With the fulguration method, 38 operations, or 49 per cent, were successful, while 40 operations, or 51 per cent, were not successful.

RESULTS OF OPERATIONS FOR DETACHMENT OF THE RETINA AT THE ILLINOIS EYE AND EAR INFIRMARY

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ALTHOUGH the modern surgical treatment of detachment of the retina began in 1928 following Gooin's presentation of his technique at the Amsterdam meeting of the German Ophthalmological Society it was not until 1934 that the present methods of surgical approach were begun at the Illinois Eye and Ear Infirmary. These methods were instituted simultaneously with the reorganization of the Infirmary staff when younger and more progressive men on the attending staff became affiliated with the Institution.

In 1934 we were first able to acquire a Walker diathermy unit. Previous to that time an electric cautery constituted the entire armament. In the earlier years, some of the attending surgeons loaned their Walker pen sets for infirmary use. Later we acquired a Grädle diathermy needle to use in conjunction with the Walker diathermy machine, and for the past 5 years this has been the choice method of procedure, probably due to the ease with which it can be manipulated.

The surgical management consists of a thorough study of the fundus, allowing time, if necessary for several days' bed rest, so that the retina may flatten out if possible before surgical intervention. A rough sketch of the fundus picture is made with blue and red crayons: blue designates the detached area, and red the holes or tears present. The tear is localized as accurately as possible by direct or indirect ophthalmoscopy with the pupil maximally dilated. Pre-operative medication usually consists of a hypodermic injection of $\frac{1}{4}$ grain of morphine sulfate or 0.010 gram, and $\frac{1}{100}$ grain of scopolamine hydrobromide or 0.0005 gram 1 hour before the time of operation. Anesthesia is obtained by the instillation of $\frac{1}{4}$ per cent pontocaine hydrochloride at 3 minute intervals for 4 doses. The lashes are excised with scissors. A retrobulbar injection of 1 cubic centimeter of 1 to 4 per cent novocaine solution is made and about 1 cubic centimeter of the same solution is injected subconjunctivally over the region of the sclera to be exposed. A speculum is inserted and the

conjunctiva is exposed in the area of the tear by means of a curved incision parallel to the limbus and 10 millimeters posteriorly. The conjunctiva is completely undermined back to the posterior part of the eyeball depending upon the exposure necessary. The underlying rectus muscles are isolated and controlled with black silk bridge sutures, or if necessary they may be temporarily resected and held out of the way with catgut sutures which later are used to sew the muscle back in place. The latter procedure is avoided if possible as diplopia may result later. Isolated, flat retractors are used to obtain a good scleral exposure. The cornea is moistened constantly by saline solution instillations, so that it may remain transparent and not hinder ophthalmoscopic examination during the operation for puncture orientation. The exposed sclera is thoroughly dried with cotton sponges, and multiple, non-perforating punctures are made in the region of the tear with the Grädle needle. The fundus is examined at intervals to discover whether the punctures are correctly located. They are identified as small, white, cloudy areas. If the location is correct, a barrage of non-perforating diathermy applications is made. These punctures should hit the tear or else wall it off, and their number varies according to the size of the involved area. Several perforating punctures are then made in the most dependent portions of the detachment to allow for escape and seepage of the subretinal fluid. In the past, 1 or 2 scleral trephine openings were made and the choroid punctured with a dull-pointed instrument instead of the perforating punctures. But this method of drainage is now abandoned. If further ophthalmoscopic examination reveals the fact that the tear or tears are well circumscribed by white, cloudy areas of choroidoretinitis resulting from the diathermy current, the recti sutures are removed, and the conjunctiva is sutured by a continuous black silk suture which is left untied at both ends. A 1 per cent solution of atropine sulfate is instilled and both eyes are bandaged.

The eyes are dressed daily and the pupil is kept dilated with atropine. Absolute bed rest is imperative with the site of the perforating punctures in a dependent position. The bandages are re-

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TABLE I—AGE OF PATIENT AT OCCURRENCE OF RETINAL DETACHMENT

Age in years	Cases	Age in years	Cases
10 to 19	17	50 to 59	44
20 to 29	15	60 to 69	16
30 to 39	14	70 to 80	10
40 to 49	24		

moved on the fourteenth day, and the patient is given hole spectacles and allowed up about the eighteenth day.

One hundred seventy histories were examined and these included all cases of retinal detachment admitted to the infirmary from 1934 to 1939. Thirty cases had to be excluded because they were too recent to be included in this series. The total reported consists of 140 patients with 148 eyes involved. In 68 the left eye was involved, in 64 the right eye, and in 8 both eyes.

Ninety-three cases occurred in males and 47 in females. The male preponderance is probably due to the greater hazards that the male sex is exposed to.

The age of the patients at the time of occurrence of the detachment is revealed in Table I. The greatest percentage of cases occurred in the decade between 50 and 59 years of age (Fig. 1). This can be explained partially by the fact that at this age many of the vascular changes and degenerations that the human organism is prone to have already become firmly established. At this period arteriosclerosis, hypertension, etc., are already present. Peripheral, senile, degenerative chorioretinitis in the region of the ora serrata is usually seen at this age. Many believe that these degenerative factors are indirectly related to the etiology of the so called idiopathic retinal detachment. The number of cases occurring in the fifth decade is also increased on account of the presence of aphacia, as 14 per cent of our cases were present in aphacic eyes. The average age was 37.8 years.

The length of time that the detachment was present when the patients presented themselves to the clinic is shown in Table II. The greatest number came for treatment between 2 to 6 weeks and 3 to 6 months after the onset of symptoms.

TABLE II—AGE OF DETACHMENT

Age of detachment	Cases	Age of detachment	Cases
1 to 13 days	16	19 to 23 months	1
2 to 6 weeks	33	2 years	11
1½ to 2½ months	15	3 years	4
3 to 6 months	37	4 to 5 years	3
7 to 9 months	11	6 to 7 years	2
10 to 12 months	8	12 to 14 years	2
13 to 18 months	4	20 years	1

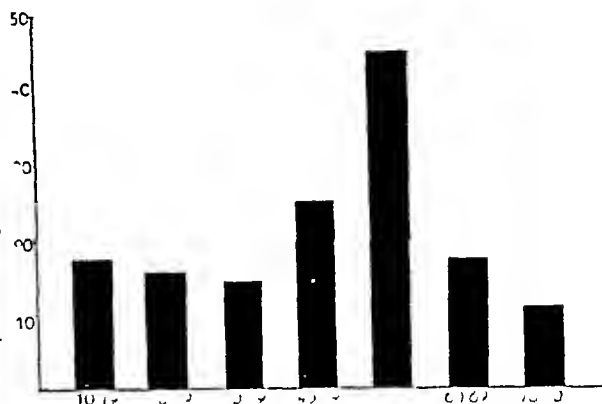


Fig. 1. Graph showing age of patient at occurrence of retinal detachment. Vertical figures represent number of cases, horizontal figures, age of patients in years.

There was a history of trauma in 32 cases or 21 per cent. Perforating injuries occurred in 2 patients. Previous surgical operations on the affected eyes were noted in 28 cases or 19 per cent, and consisted of lens extraction, 22 cases or 14 per cent, glaucoma operations, 2 cases, magnet extractions, 2 cases, and needling, 2 cases.

Tears or holes were found in 49 cases or 35 per cent. Disinsertion was found in 5 cases or 3.3 per cent. This is a relatively low incidence, but can be explained readily by the fact that the fundi were examined mostly by the house staff, the attending men did not devote enough time for such examinations. However, on one individual service, tears were found in over 50 per cent of the cases. Gonin has taught us the importance of finding retinal tears, and while most of us probably cannot boast of 90 per cent or better success in ascertaining the presence of a tear, I am certain that tears can be found in at least 60 per cent by the average ophthalmologist if he will take enough time for a proper examination.

It is important when evaluating end-results to be careful to differentiate between anatomical and functional results, because the retina may become perfectly flat, and yet the central vision may be below 20/20 due to a large central scotoma. It is well known that this may develop from a cystic degeneration in the macular region following a re-attachment of the retina. While such a case may be heralded as a surgical cure, it still is a failure to the patient.

Anatomically, there were 30 cases or 37 per cent improved, and 51 cases or 63 per cent unimproved. By this is meant a retina which has become re-attached, is perfectly flat, and remains so.

Functionally there were 28 cases or 34.6 per cent improved, and 53 cases or 65.4 per cent unimproved. This indicates that better than 1 out of 3 patients operated upon regained a flat retina and vision of 0.1 or better. The final corrected vision of the 28 functionally improved patients is as follows: 1 patient, vision of 1.0; 4 0.8; 1 0.6; 1 0.5; 4, 0.3; 14, 0.2; and 3 0.1.

A problem with which we have to contend is the fact that there are 6 individual services, each with its own attending surgeon and accompanying staff. Such a division of services leads to diverse and various methods of diagnosis and surgical procedure. Consequently some services handle certain problems more efficiently and satisfactorily than others, depending upon the ability

and enthusiasm of the surgeon in charge. Such a system will, therefore, result in a wide variance in end-results.

These results do not compare favorably with those published by individual clinics, such as the Weve or the Lindner Clinics. In our private practice cases, Grable and I have succeeded in attaining successful results anatomically and functionally in approximately 60 per cent of more than 260 operations. But the infirmity we still feel that progress is being made in spite of the variety of operators, including the house surgeons, the poor quality of the material to work upon, and the limitation of surgical armament, all of which result in a lower percentage of successfully cured patients.

RESULTS OF OPERATIONS FOR DETACHMENT OF THE RETINA AT THE MEMPHIS EYE EAR NOSE AND THROAT HOSPITAL

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THE figures at the end of this article have been carefully compiled to show the results of operations for retinal detachment performed at the Memphis Eye Ear Nose and Throat Hospital from 1928 to 1939 inclusive, which covers the period in which Gonin's ideas and operations and the modifications of the operation he proposed have been put into practice.

The early publications by Gonin were so vague as to details that it was not possible for me, at least to understand what he did, until a personal interview at the Amsterdam Congress in 1929 enlightened me. The first operation was a scleral puncture, accompanied by linear cauterization of the sclera. It was a failure. The next operations were ligature punctures with an electric cautery—Gonin used the Paquelin cautery—and most of these were failures, as were the cyanide of mercury injections after the method of Surdille of Nantes. With the adoption of the diathermy operation of Larson, Safar and Walker we began to get better results. We have not withheld oper-

ation from any one who wanted it, no matter how hopeless, especially if the patient was poor. While this has made our statistics very poor in comparison with others, we have obtained a few brilliant results. A one-eyed, 26 year old negro girl was improved from ability to perceive light to a vision of 6/6 by 4 operations, 2 scleral punctures and 2 ligature punctures.

All compilers of hospital statistics are chagrined to find essential details omitted from many case histories. This has prevented a complete report on our work. The operation which is now done at the Memphis Eye Ear Nose and Throat Hospital is practically the same with all operators. The detachment is studied with a widely dilated pupil, especially for its extent and for the presence of tears or a disinsertion. Careful transillumination is done to try to detect a tumor, but if the detachment is not fresh and if it is extensive, a comparatively small tumor is sometimes overlooked, as occurred in this series 4 times. Elaborate measurements of the site of the tear and rock aids as retractors and sutures to assist in this are not in common use nor have I seen them used elsewhere. Sometimes a pin is introduced at an early stage of the operation and the relation of

it to the tear observed with the ophthalmoscope, but as a rule we plan our operation beforehand and proceed with that plan. Study of the eye ground during the operation in a room not completely dark and with a disturbed and often distorted cornea has not helped us any in proportion to the time it takes.

The operation as a rule consists in a wide circle of contact diathermy applications, with a Larsson tip, a Gradle needle, or a LaCarrère instrument. The latter is open to the objection that the sclera is perforated and fluid runs out which permits the ball to collapse. The tear or disinsertion is then surrounded with Walker pins and the sclera punctured or trephined to draw off the interretinal fluid. We do not like to apply suction to draw off this fluid.

We are not agreed or satisfied as to the length of time necessary to keep a patient in bed or immovable after the operation. We vary the position according to the location of the detachment, and most of these patients have been kept flat in bed for 1 or 2 weeks, movement, especially of the

eyes, is restricted as much as possible for a month or 2 longer.

The technique of the operation and after-care needs to be standardized. We do not attempt from this small number of cases to say how it is best done.

The number of patients in this series was 88, including 53 males and 35 females. One hundred thirty operations were performed, 28 tears and 11 disinsertions were found. The causes of detachment were as follows: myopia, 8, trauma, 24, tumor, 4, no cause was given in 51 cases. The types of operation employed were: cautery to the sclera, 5, ignipuncture, 23, injection of mercuric cyanide, 3, diathermy, 95, and sclerotomy, 4. The visual results were: 33 improved, 48 unimproved or worse, 8 with a vision of 6/9 or better, and 7 were not recorded. There was full restoration of the visual field in 19, improved in 29, and unimproved or worse in 58. Anatomically, there was total re-attachment in 22, improvement in 12, no improvement in 47, and no record of anatomical results in 7 patients.



SYMPOSIUM RESPIRATORY DISEASES

THE TREATMENT OF THE ACUTE OR RECENT PULMONARY ABSCESS

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PULMONARY abscess continues to be a serious and oftentimes fatal malady. To me the most significant fact which emerges from a study of this disease is that in spite of a great increase in our knowledge of its etiology, of the perfection of methods used in its diagnosis and localization, of the application of improved supportive measures, and of presumed advances in the technique of its treatment, the mortality attending it remains discouragingly high. It is a disturbing fact and demands an explanation. One wonders whether the disease itself has gradually increased in its severity thus nullifying the improvements in our treatment or whether our present methods of treatment are wrongly conceived, or if sound whether they are poorly applied.

My experience in the treatment of pulmonary abscess may be divided roughly into two periods: an earlier period which terminated, perhaps, around 1930; a later period which has continued to the present time. In the earlier period the concept of a pulmonary abscess handed on to me by my predecessors was a simple one, namely, that it was an abscess much like an abscess elsewhere in the body. The ideas concerning its treatment also were simple. Like abscesses elsewhere, surgical drainage should be established as soon as a positive diagnosis had been made. It was, then, a period of straight-forward, surgical therapy based upon what is usually a sound surgical principle. It was also a form of therapy concurred in by the internist, who, on making a positive diagnosis, placed the responsibility for treatment in the hands of the surgeon. There are records of the results of the treatment of pulmonary abscess during this period.

The second and later period has witnessed not only a great increase in our knowledge of

the etiology, pathology and diagnosis of pulmonary abscess but also the introduction of new methods of treatment. The observation that pulmonary abscess may undergo spontaneous cure led to the introduction by Garvin of postural drainage as a method of treating pulmonary abscess, and in a paper on pulmonary abscess published early in 1932 I reported my first case of cure by this method. There followed the introduction of bronchoscopy, of artificial pneumothorax, and of phrenicectomy in the treatment of the earlier abscesses of thoracoplasty, of early pneumonectomy and pulmonary lobectomy in the treatment of the older refractory and complicated abscesses. Intravenous and vaccine therapy also were introduced and seemed, at first, to offer promise in certain groups of cases. Surgical drainage which occupies the key position in the treatment of the acute abscess in the earlier period, was supplanted by the more conservative methods and has come to occupy a position on the side lines to be called back upon the field only when conservative methods fail. The opinion often expressed that surgical drainage, if used in the treatment of the acute abscess, results in disaster is now quite generally accepted in spite of some observations in the early period contrary to that opinion. The relation of the internist and surgeon has changed. With the introduction of conservative methods of treatment, the internist, who previously transferred the responsibility of treatment to the surgeon, has assumed this responsibility to a greater or lesser extent, and is treating the condition often without sufficiently early surgical consultation.

That the treatment of pulmonary abscess, after the enormous effort of this second period, can be viewed with something distinctly less than satisfaction is, perhaps, sufficient justification for again examining into methods of treatment. In doing so I shall call upon my own experience and the experience of others as reported in the literature. I shall confine myself to the single or self-

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tary abscess occurring in one or more lobes, and shall leave out the consideration of multiple abscesses from whatever cause. I shall confine myself still further to the treatment of the acute or recent abscess, for I believe this to be the essence of the problem.

Perhaps I had best begin by reviewing very briefly the pathological and clinical course of pulmonary abscesses as we observe them in patients in our hospital wards. It is a composite picture I wish to present, one which portrays the history of an abscess from its inception to its late stages or termination. Pathologically it begins as an area of consolidation in the lung which in time undergoes liquefaction. Usually the liquid pus is evacuated through a bronchus, and after this primary evacuation a pulmonary abscess is a cavity within the lung without a visible or palpable wall. On more than one occasion I have inserted my finger into such a cavity; its boundaries feel soft and velvety and fail to give to the palpating finger any sense of resistance greater than that of pulmonary tissue. An abscess in this stage of its evolution collapses at once and completely after the evacuation of its contents, and often will heal with astonishing rapidity if opened surgically. If measures directed toward its cure in this stage fail, a series of pathological events may occur. A rapidly spreading pneumonitis or gangrene of the lung may develop sooner or later in the course of the disease which will terminate the life of the patient. A rigid and increasingly heavy, fibrous wall may be laid down about the cavity which tends to defeat efforts directed toward its obliteration. The inflammatory process may extend from the original abscess to the parietal pleura which gives rise to empyema or pyopneumothorax. Erosion or invasion of the surrounding blood vessels by the inflammatory process may occur and cause hemorrhage or, through septic embolism, brain abscess. Periodic attacks of bronchopneumonia, if not fatal, may be followed by softening of the areas of consolidation causing multiple abscesses about the original one, and associated fibrosis may lead to local bronchial dilatation and eventually cause a condition of chronic pulmonary suppuration which is hopeless from the viewpoint of treatment save by cauter pneumonectomy or pulmonary lobectomy.

Clinically, the manifestations of this disease parallel its pathological evolution. The early symptoms before liquefaction of the abscess has taken place are well known together with those accompanying the sudden evacuation of pus through the bronchus and those which supervene during the transition from a condition of acute

inflammation to one of subacute or chronic sepsis. So, too, the more serious manifestations associated with a spreading pneumonitis have been observed: periodic attacks of bronchopneumonia, single or repeated massive hemorrhages, empyema and pyopneumothorax and brain abscess. I have no doubt all have seen patients in the stage of chronic pulmonary suppuration one or more years after the onset of the acute abscess. These are tragic individuals who arouse the pity and often defeat the best efforts of the surgeon.

In hospital practice it is possible to observe patients in every phase of the pathological evolution of pulmonary abscess which I have just reviewed. The experience gained by observing and treating them makes it quite evident that the various pathological conditions which may develop from the early abscess are largely responsible not only for the difficulties in treatment but also for the high mortality in this disease. It also teaches us that the course of an abscess often cannot be predicted accurately from clinical symptoms, for repeatedly it happens that a patient whose clinical course has been reasonably satisfactory, suddenly or insidiously develops one or another of the serious complications I have described which may terminate life. For these reasons the most important single problem in the treatment of pulmonary abscess is its prompt cure in its acute or early stage. It is a statement of fact which my own experience and the experience in the literature suggests is frequently disregarded both by physicians and surgeons.

In the treatment of the acute or recent abscess at the present time the almost universal practice is to use conservative or palliative methods combined with supportive treatment. The conservative methods include postural drainage, bronchoscopic treatment, artificial pneumothorax, and phrenicectomy or phrenic nerve crushing. The rationale of the first two is to promote adequate drainage through a bronchus and so effect a cure without the necessity of external surgical drainage. The rationale of the second two is to obliterate the abscess cavity through the collapse of the lung. I shall attempt again to evaluate these methods both from my own experience and from the experience of others.

1. Conservative therapy. My experience with conservative methods is best illustrated by a study of the New York Hospital series. Between the years, September, 1932, and September, 1939, 100 patients with pulmonary abscesses were admitted to the surgical wards. Two patients were admitted in a moribund condition and died untreated, 24 patients had multiple pulmonary

abscesses which, as I have said, will be excluded from consideration and 10 patients had pulmonary abscesses secondary to carcinoma of the lung in 8 or carcinoma of the esophagus in 2. These I also exclude. There remain 64 patients. Of these, 55 were believed to have uncomplicated solitary abscess and were treated primarily by conservative methods, while 9 were admitted with abscess complicated by pyopneumothorax and were treated primarily by surgery.

In the 55 patients with presumed uncomplicated solitary abscess the conservative measures used were almost exclusively postural drainage supplemented occasionally by bronchoscopic treatment. Previous experience led me to believe that little is to be expected from the more frequent use of bronchoscopic methods, artificial pneumothorax, or phrenicectomy that well supervised postural drainage does not offer. One patient in this series was given artificial pneumothorax and promptly developed empyema, and 1 patient was subjected to phrenicectomy without benefit.

Of the 55 patients treated conservatively 26 appeared to be making favorable progress and no other more radical treatment was employed. Of these 26 patients, 16 recovered and are at present well, 10 failed to recover and I believe are now dead. Of the 10 supposedly dead, 7 are known to be dead and 3 are most probably dead. The 3 left the hospital against advice unimproved, with abscesses still present, and cannot be traced. A study of the patients who died shows that they developed untoward symptoms rather suddenly which made impossible the application of other more radical measures. Five patients during the course of conservative treatment developed a fatal spreading pneumonia, 1 developed multiple brain abscesses, and 1 meningitis. The results of our conservative treatment, limited to this group, show that 61.5 per cent of our patients recovered and 38.5 per cent died.

While 26 of the 55 patients appeared to respond favorably to conservative therapy 29 patients did not. At variable times after conservative measures had been tried, these patients were subjected to surgical drainage. The total results, including late follow-up studies, show that 19 or 65.5 per cent are well and 10 or 34.5 per cent are dead. Among the dead are 3 patients who at autopsy had multiple abscesses, only 1 of which had been drained.

Summarizing this experience I might say that in a selected group of 55 patients with pulmonary abscesses 26 were treated by conservative methods of whom 61.5 per cent recovered and 38.5 per cent died and 29 were treated by surgical drainage of

whom 65.5 per cent recovered and 34.5 per cent died. But with reference to the results of conservative treatment such a statement, I think, is misleading for it does not take into account the cases which failed to respond to conservative measures. Would not a more correct statement of the results of our conservative measures be that they succeeded in 29 per cent and failed in 71 per cent of our patients and that 29 per cent of cures were achieved at the cost of an 18.2 per cent mortality?

It is difficult to form an estimate of the value of postural drainage from reports in the literature. Some authors base their results on the condition of the patient at the time he leaves a service or at the time of discharge from a hospital. Others fail to take into consideration anywhere from 30 per cent to 60 per cent of the cases in which postural drainage is unsatisfactory and which are transferred to surgery or elsewhere. Such reports fail to give a true picture of the results of postural treatment. Again, not a few authors have used successively or together a number of methods as postural drainage, bronchoscopic treatments, artificial pneumothorax, and phrenicectomy. It is impossible in these to evaluate the results of a single method. A review of the literature shows that postural drainage is reported to have achieved satisfactory results in from 30 per cent to 80 per cent of the cases the majority perhaps, show 50 per cent or better. But when I analyze these reports from the viewpoint of the total number of patients subjected to this form of therapy I conclude that 25 to 30 per cent represents a generous average of the satisfactory results which have been attained. The unsatisfactory results are even more difficult to appraise. Based upon total numbers subjected to this form of therapy the mortality varies between 13.5 and 36 per cent and averages 24.8 per cent in 6 large series of cases. This statement does not, however give the whole story for it leaves out the consideration of a chargeable secondary mortality following surgery in patients treated too long by postural drainage and a consideration of late complications which occur after the patient has been discharged from the clinic. Nor do the reports generally published take into account, even if fatalities are averted, the long period of hospitalization and the secondary and successively more serious operations performed. I would say then, that a fair appraisal of postural drainage as a method of treating pulmonary abscess is that it achieves 25 per cent satisfactory results at the cost of a 25 per cent mortality.

2. *Bronchoscopy* I have never considered bronchoscopic treatments as a method per se in

the treatment of pulmonary abscess but rather as an adjunct to other methods. As an adjunct, bronchoscopy is particularly valuable in contributing to the accurate localization of abscess, in the differential diagnosis between simple abscess and abscess secondary to carcinoma of the lung, in determining the presence of a non-opaque foreign body, and in establishing and dilating, for the purpose of better drainage, a bronchial stenosis or partial occlusion proximal to an abscess. As a method of treatment it has been employed only occasionally rather than routinely, and when used it has been for the purpose of assisting postural drainage.

Perhaps in my own cases I have minimized the importance of bronchoscopy as a method of treatment. In the literature there are favorable reports from the use of the method. Flick, Clerf, Funck, and Farrell found that of 161 patients with pulmonary abscess treated medically, bronchoscopically, or surgically, 50.3 per cent recovered, 29.8 per cent were improved, 5 per cent were unimproved, 1.2 per cent recurred, and 13.7 per cent died. An unusually high percentage of their 172 patients were treated bronchoscopically. Of the 127 so treated, 6 were still under treatment at the time of the report. Of 121 patients in whom bronchoscopic treatments had been employed and completed, 54 per cent recovered, 13 per cent were improved, 6 per cent were unimproved, 23 per cent were referred to surgery, and 2.4 per cent died. Kernan found that of 103 patients with pulmonary abscess, 68 had 3 or more bronchoscopic treatments. Of the 68 patients, 45.5 per cent were cured, 22 per cent were improved, and 13.2 per cent died. Four patients were still under treatment and 9 could not be traced. Allen and Blackman collected 650 cases from the literature in which bronchoscopic drainage was, in their opinion, the principal form of treatment. Of the 650 patients, 61 per cent are reported as well, 20 per cent as improved, 12.5 per cent as unimproved, and 6 per cent as dead. Of the larger series of cases these are the best results which have been reported and, indeed, they appear impressive. Other reports are not so favorable and a mortality rate as high as 20 per cent to 25 per cent has been reported following the use of the method. Those with the largest experience point out that the early abscesses and particularly the abscesses following tonsillectomy respond most favorably to this method of treatment.

It is always difficult to evaluate a method which forms not the sole but a part of the treatment of a condition. Bronchoscopy is used in conjunction with postural drainage and with the purpose of

securing more adequate drainage. To what extent it has contributed to the success of non-surgical drainage cannot be stated dogmatically. Its greatest successes have been obtained in cases in which postural drainage alone is most likely to succeed, and it does not appear to have contributed greatly in cases in which postural drainage has failed. Although I have reviewed the literature since my last paper on pulmonary abscess, my attitude toward bronchoscopy remains the same, namely, that it occupies an important but still a secondary rôle in the treatment of the acute or recent abscess, and that it should be utilized only when the services of an expert bronchoscopist are available.

3 Artificial pneumothorax. With this method I again have little personal experience for I have never been convinced that its application to pulmonary abscess was sound therapeutics. It was introduced as a method of treating pulmonary abscess because of its success in the treatment of pulmonary cavitation incident to tuberculosis. The 2 conditions are not similar nor are the objectives of treatment the same. There is little doubt that patients with pulmonary abscess have recovered after the use of artificial pneumothorax but a review of the literature shows that little is to be expected from the method in the treatment of this condition. In Miller and Lambert's last series of 40 cases it was used in 10 in conjunction with rest and posture. One patient recovered, 2 were improved, and 7 were not improved and were referred to surgery. King and Lord in 210 cases attempted to use it in 22. In 6 patients collapse failed, in 4 partial collapse was obtained, and in 12 complete collapse. Of the 16 patients in whom partial or complete collapse was obtained, 1 recovered, 3 were improved, 9 were unimproved and referred to surgery, and 3 died. There are many more reports in the literature which I might quote and many opinions of men who have had experience in the treatment of abscess. It would appear that as a method it has proved unsatisfactory. It has a limited field of application, it not infrequently fails to achieve its purpose, and it is attended by the danger of empyema or pyopneumothorax.

4 Phrenicectomy or phrenic nerve crushing. As a method, phrenicectomy also must be considered as an adjunct to postural drainage. Reports in the literature regarding its value are conflicting. Allen and Blackman used it in 26 of 100 cases and in conjunction with postural drainage and other conservative measures. Of the 26 patients 12 recovered, 3 were improved, 10 unimproved, and 1 died. Of the 13 improved or unimproved 10

were referred to surgery. Lueth in a series of 101 cases treated 8 patients by this method. Six were improved and 2 died. King and Lord treated only 2 of 210 patients by this method of which 2 was not improved and 1 died. Many other reports of small numbers of patients treated by this method occur in the literature. I think it can be said that thus far the application of this method has been limited and that the results obtained have not been striking.

5. Surgical drainage. As stated earlier surgical drainage at the present time is not often a primary but a secondary method of treating pulmonary abscess. Generally speaking it is now reserved for what, from the viewpoint of treatment, are the undesirable groups of pulmonary abscess the abscesses in which conservative measures have failed, the chronic abscesses with thick rigid walls, the abscesses complicated by empyema and pyopneumothorax, and so forth. In these unfavorable groups of cases it has achieved a certain measure of success and in my own experience at the New York Hospital surgical drainage in a distinctly less favorable group including all patients with pyopneumothorax yielded only slightly less favorable results than postural drainage.

It is not, however, its present field of application which I wish to discuss but a reconsideration of its use in the treatment of the acute or recent abscess. A comparison of my latest with my earliest experience in the treatment of pulmonary abscess is interesting in this connection. If I exclude from both series the multiple abscesses due to generalized infections and those due to primary malignant disease of the lung and esophagus, there remain 64 cases in the New York Hospital series and 44 in the Johns Hopkins Hospital series. As a result of the treatment of these two groups of patients 60 per cent of the New York Hospital series recovered and 40 per cent died while in the Johns Hopkins Hospital series 80 per cent recovered or were improved and 20 per cent died. An examination of the methods employed shows that in the New York Hospital series 55 of the 64 patients were treated primarily by conservative methods, 9 patients whose conditions were complicated by pyopneumothorax, were treated primarily by surgery and subsequently 29 patients were treated secondarily by surgery. In the Johns Hopkins Hospital series 3 of the 44 patients were treated primarily by conservative methods, 41 by surgery and subsequently 2 of the total number was treated secondarily by lobectomy. These findings suggest that the better results obtained in the early series were due to a more consistent use of surgical methods in the

acute or recent abscess. A comparison of the results of surgical drainage in the 2 series suggests further that surgical drainage may be expected to give better results in the acute abscess than in the later more refractory abscess. If I include in both series 1 patient who presented the complication of pyopneumothorax or had multiple abscesses only 2 of which had been drained, surgical drainage in 38 patients in the New York Hospital series resulted in the recovery of 57.9 per cent and in the death of 42.1 per cent of the patients in the Johns Hopkins Hospital series recovery or improvement resulted in 71.4 per cent and death in 28.6 per cent of the patients, which includes 1 death from lobectomy. If I exclude from each series the 11 patients who presented the complication of pyopneumothorax or had multiple abscesses, only 2 of which had been drained, in other words, if I confine myself to the uncomplicated solitary abscess, surgical drainage in 27 patients in the New York Hospital series resulted in the recovery of 70.4 per cent and in the death of 29.6 per cent of the patients. In the Johns Hopkins Hospital series 24 patients or 95.8 per cent recovered or were improved and death occurred in 4.2 per cent of the patients. I wish to point out that the results as I have just reported them are not quite comparable. Those for the New York Hospital are I believe, accurate for they include almost complete follow-up studies; those for the Johns Hopkins Hospital series may not be wholly accurate for in some cases the late follow-up records are lacking. But in those in which such late reports are lacking, the favorable condition on discharge leads me to believe that the large majority recovered.

This from my own experience is evidence in favor of surgical drainage as a primary or early treatment of the acute or recent abscess. Further evidence is the changing viewpoint of a number of observers who have studied the subject intensively and who are gradually shortening the period of conservative treatment in favor of earlier surgical drainage. Most impressive is the experience of Neubol and Tourouff who have reported two series of cases, the first including 37 the second 45 patients with pulmonary abscess. Their viewpoint of the treatment of the acute early abscess differs from that underlying the present common practice. They do not advocate the treatment of every acute abscess by surgical drainage but they believe, as a result of their experience that an increasing number of pul-

*Other evidence in the New York Hospital series supports the belief that patients discharged from the hospital "improved" and with good prognosis, have recovered, 10 years after discharge from acute abscess.

monary abscesses should be treated in the acute stage of the disease by surgical drainage. Of 45 patients treated by surgical drainage in the acute stage, 40 or 89 per cent are well, 3 or 6 per cent are improved, and 2 or 4 per cent have died. There is much in these two publications which should be studied seriously by physicians and surgeons.

SUMMARY AND CONCLUSIONS

I have reviewed the pathological and clinical course of pulmonary abscess. It is a disease characterized during its course by the occurrence of unusually fatal complications including pneumonitis, gangrene of the lung, bronchopneumonia, pyopneumothorax, pulmonary hemorrhage, and brain abscess. If one follows the life history of 100 patients with pulmonary abscess treated by present methods, he finds happily that a certain number recover, but unfortunately he sees patient after patient drop from the list due to these complications. In addition he observes in patients, who have failed to recover promptly but who have escaped death, the development of a chronic stage of the disease with abscesses surrounded by heavy rigid walls, with secondary multiple abscesses, and with abscesses associated with bronchiectasis. An entire lobe of the lung becomes involved in the chronic suppurative process, and in an effort to relieve the patient of an intolerable condition he must perform successively larger and more serious operations which carry with them a high mortality. Even those who survive are by no means always cured for he finds in follow-up studies that some eventually die from chronic sepsis, brain abscess, or pneumonia. The total results of present methods of treatment in our hands, based upon 100 patients, is that 60 recover and 40 die, but it is to be added that the results probably would not have been so good had we treated 100 instead of 64. Cutler and Gross have followed 90 patients. Of these 53 are well and 35 have died, but the eventual outcome of the 13 patients listed as improved and the 9 unimproved or not followed remains problematical. I think, on the basis of my own experience and my review of the literature, that I would err on the side of optimism were I to conclude that 50 of every 100 patients treated by present methods die of the disease.

In a search for the reasons for these unsatisfactory results I have confined myself to the present commonly accepted treatment of the condition, leaving out a consideration of the factors which undoubtedly influence the outcome of the disease. The most serious fault with the treatment lies in

the failure to cure the acute abscess promptly. I have reviewed the conservative methods now used in the treatment of the acute or recent abscess. I have ventured also to re-emphasize surgical drainage as a radical method of treating this condition. From a study of these conservative and radical measures I have formed opinions.

The therapeutic value of rest and supportive measures including blood transfusions cannot be doubted and these measures form a not unimportant part of the treatment of pulmonary abscess. Artificial pneumothorax and phrenicectomy appear to have added little to the therapeutics of the disease, and, in my opinion, might well be discarded in the treatment of the acute or recent abscess. Bronchoscopy has proved to be a valuable aid in the diagnosis and localization of abscess, and it may be of service in securing better drainage by postural methods. Postural drainage finds its greatest usefulness in the treatment of the smaller acute abscesses with relatively mild symptoms such as those following tonsillectomy, but as a method applied in the treatment of all acute or recent abscesses, it leaves much to be desired. The fault seems to lie in two directions: in an improper selection of cases for its use and in its too prolonged use. My own experience and the experience of others would indicate that in the large acute abscesses with highly toxic symptoms, postural drainage is sometimes inadequate to meet a situation which surgical drainage may control. Its too prolonged use invites the dangerous complications which contribute in greatest measure to the mortality. It is a mistake to believe that these are late manifestations, and, therefore, one may safely proceed with postural drainage. In the New York Hospital series, 40 per cent of the total deaths in those treated by postural drainage occurred within 2 months after the onset of symptoms. Of 9 cases of pyopneumothorax in the series, 4 occurred within the same period of time. Rives, Major, and Romano, in an analysis of the causes of death in 100 consecutive fatal cases, found that spreading pneumonitis was the greatest and pyopneumothorax the second greatest cause of death. In 88 of the 100 fatal cases the duration of illness is known, and of these it was more than 1 month's duration in less than half the cases and more than 3 months' duration in less than one-fifth of the cases. Could the occurrence of these serious complications be foretold by the clinical course of the disease, they might be averted by resorting to other methods of treatment. However, they cannot always be foretold. Surgical drainage as a method of treating the acute or recent abscess should be restudied seri-

ously. It was replaced by conservative methods because of early reports of its high mortality. It is interesting to reread these early reports. In a paper published in 1919 Frederick T. Lord reported the results of treatment of 100 cases. Of these 38 were not subjected to operation and 24 died or a mortality of 63 per cent, while 14 were alive or untraced at the time of the report. Of the 14 alive, 7 recovered spontaneously and 7 when last seen, continued to cough and expectorate. Sixty-two of the 100 patients were subjected to operation, of whom 35 died in the hospital or a mortality of 56 per cent. But when one considers the patients subjected to operation he agrees with Lord that 29 of the 35 deaths occurred in patients already doomed before operation was undertaken. They were patients with multiple abscesses, an associated pneumonia, brain, liver, and subphrenic abscesses, carcinoma, general sepsis, and advanced myocardial disease. Only 6 deaths occurred in 33 patients without these fatal complications. In an early study of the treatment of pulmonary abscess published in 1921 I found that of 24 patients with uncomplicated abscess treated by surgical drainage in the acute stage of the disease only 1 patient died, leaving a mortality rate of 4.1 per cent. Whittemore in a study of his second series published in 1921 reported a 5.8 per cent mortality following surgical drainage. The opinion expressed in these early reports is that it is the single abscess in its acute stage which responds most favorably to surgical drainage. The recent reports of Neubof and Touraiff would seem to confirm it.

If the above opinions were formulated into a plan for the treatment of the acute abscess, this plan would include postural drainage and surgical drainage as methods of treatment and rest, supportive measures and bronchoscopy as important adjuncts to these methods. As soon as an abscess becomes recognizable as such, which it usually does in 5 to 10 days after the onset of symptoms, postural drainage and surgical drainage would be considered as competitors in its treatment and not as 2 methods of which the latter is supple-

mental to the former. The idea that surgical drainage, if employed early must necessarily result disastrously is rejected in this plan rather it is considered a method which may save lives if promptly used. The idea that postural drainage may be used safely over prolonged periods is abandoned. Instead the period of its use is shortened possibly to a month after the onset of symptoms unless striking results are obtained. Its early abandonment in favor of surgical drainage is considered advisable even with the knowledge that some patients will be subjected to operation who might eventually be cured without it for it is a viewpoint which has proved sound in other acute conditions. Such a plan implies a closer relationship between physician and surgeon, first rate diagnosis, accurate localization, keen judgment, and a high degree of surgical skill.

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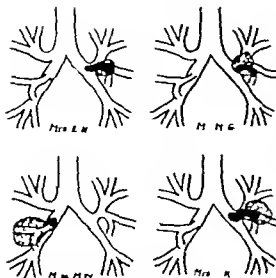


Fig. Outline of stem bronchus in 4 cases of operable bronchiogenic cancer based on bronchoscopic findings and from surgical specimens. Intrabronchial portion in solid black, extrabronchial portion, shaded. Mrs. E. H., age 43. The tumor originated in the lateral inferior wall of the left upper lobe bronchus and projected well into the lumen. Carcinoma simplex; glands not involved. Patient is now well 5 years and 4 months after left pneumonectomy (Figs. 5, 6 and 7). Mr. M. G., age 45. The tumor was an annular growth involving the left upper lobe bronchus. Obstruction not complete. Epidermoid carcinoma, grade II. Bilar gland involved; mediastinal glands negative. Patient is well and doing 3 years and 3 months after left pneumonectomy. Mrs. T. K., age 45. Tumor originated in left upper lobe bronchus centimeter from bifurcation. Two-thirds of the tumor was growing outside of bronchus. Small cell carcinoma, glands not involved. Patient is living and well now 5 years and 5 months after left pneumonectomy.

TABLE I.—CARCINOMA OF THE LUNG SUMMARY OF 104 CASES OBSERVED IN 6 YEAR PERIOD

Survey method	No.†	Operation type	No.	Operation recovery %
Autopsy	6	Bronchoscopic;		
Bronchoscopy	56	resection		
Biopsy	3			
Pleural fluid		Lobectomy	4	3
Sputum				
Exploration	5	Pneumonectomy	7	

*In this group 3 cases were unoperated biologically. It yielded them for diagnosis, and 17 were accepted for surgical treatment.

†All proved carcinoma. Reports by Ewald, Lewis, Borden, Jensen, metastatic lesions, and carcinoma have been included.

‡Small lesions in right lower lobe bronchus in patient 23 years of age. Mrs. M. A. Biopsy revealed small cell carcinoma of low grade malignancy. Bronchoscopy and treatment by Dr. R. B. Hoover who reports that the patient was well and free of evidence of disease 7 years and 10 months later.

TABLE II.—RESULTS OF THORACIC EXPLORATION FOR PRIMARY MALIGNANCY IN 53 SUSPECTED OR PROVED CASES

Pre-operative diagnosis	Exploratory		
	No.	Operation of tumor found %	Resection Lobectomy Pneumonectomy %
Verified	50	3	3
Unverified	30	14†	4

*Carcinoma was suspected but not found upon exploration in 3 patients. Before thoracic exploration these 3 cases were grouped among those in whom preoperative diagnosis of carcinoma of the lung had been made. Since this diagnosis was disproved, they have not been included in the group of the cases reported. Notations of these made to show how often cancer was not found upon exploration with surgical biopsy.

†Tumor was observed for diagnosis in 3 cases, but not obtained in 2; upon resection malignancy was found in 1 patient.

bronchus involved and upon the presence or absence of an associated infection. A heavy ache or sense of constriction in the chest or even dyspnea may be experienced fairly early as a result of a relatively small growth occluding a first or second division bronchus. Fever and other constitutional effects of infection may also appear early and thereby bring the patient under observation while the obstructing lesion is relatively small. Fifty-three per cent of patients in this series had fever on admission.

Symptoms referable to the lung did attract attention to the chest of every patient in the author's series except 2, or 95 per cent. In the great majority of the inoperable cases chest symptoms antedated those due to metastatic disease by several months or years.

3. *Desirability of chest roentgenograms.* Not only the desirability but the absolute necessity of roentgenograms to aid in diagnosis of pulmonary lesions is being appreciated more generally. The early diagnosis campaign now being waged by phthisiologists throughout the entire country and their dependence on chest roentgenograms have done much to educate the profession to this diagnostic necessity. Furthermore, cough, hemoptysis, or other pulmonary symptoms frequently direct patients to sanatoria or tuberculosis clinics. From this source alone many early lesions should be discovered.

The density of the lung structure lends itself to roentgenographic contrasts better than any other visceral organ. Furthermore, a small lesion which is strategically located in the bronchial lumen will give early telltale evidence of its presence by producing either an area of emphysema due to partial obstruction, an atelectatic shadow due to complete obstruction, or both. In the event that the lesion originates in one of the smaller bronchi in the periphery of the lobe which was the case in 25 per cent of the author's series, it

TABLE III —THEORETICAL CURE RATE AS BASED ON A STUDY OF 100 CASES*

	Cases
A Patients showing extrapulmonary extension—	
Metastasis upon clinical examination	62
(Includes cases first diagnosed at autopsy)	
Rejected because of age or poor general condition	4
Metastasis found at exploration	14
Operative deaths—autopsy revealed metastasis	3
Late deaths—autopsy revealed metastasis	3
(1 pneumonectomy 2 lobectomies)	
Total	86
B Patients showing no extrapulmonary extension—	
Operative deaths—autopsy revealed no metastasis	3
(2 pneumonectomies, 1 lobectomy)	
Late death in successfully treated patient, autopsy showing no metastasis	1
Postoperative patients living and well without evidence of metastasis (one patient treated by bronchoscopic fulguration)	10
Total	14

*Two apparently operable patients who refused operation were omitted. Also freedom from extrapulmonary extension could not be positively determined in 2 patients without autopsy, who died following operation. These 2 patients have also been excluded in the above table.

will not produce atelectasis at an early stage, but the tumor itself will cast a shadow. In the past it has been the discrete shadow of a peripheral type tumor that was more likely to be detected than the small bronchus-occluding tumor that produced no direct shadow of the tumor itself but merely an atelectatic shadow. An excellent description of roentgenographic changes in the lung fields resulting from bronchial obstruction has been given by Westermarck.

4 *Accessibility of the tumor to visualization and biopsy.* It has already been said that three-fourths of the tumors originate in the major bronchi. Most of these can be visualized bronchoscopically and will yield tissue for microscopic study. In our series of verified cases, 62 were of the stem bronchus type. Fifty-nine patients in this group were examined bronchoscopically and a positive biopsy obtained in 56 instances. In view of the fact that many laryngologists and most thoracic surgeons are skilled in carrying out this essential diagnostic procedure, bronchoscopic facilities are available in most centers throughout the country. Bronchoscopy has now become so much a matter of routine in many general hospitals and sanatoria that there is little hesitancy on the part of physicians to recommend it, or of patients to submit to it.

CARCINOMA OF THE LUNG—A SURGICAL PROBLEM UNTIL PROVED OTHERWISE

There is general agreement as to the most effective method of handling patients suspected of harboring malignancy of abdominal viscera

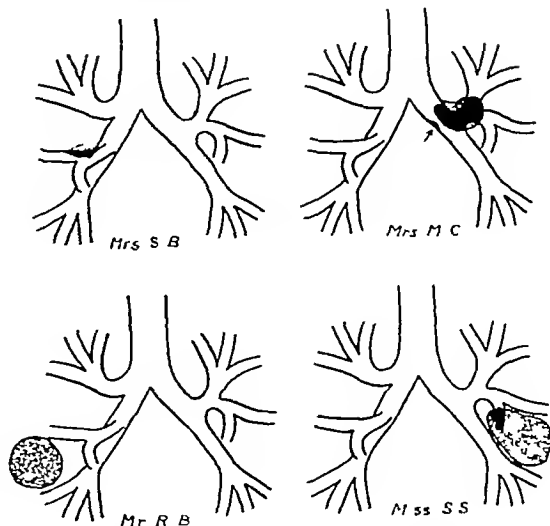


Fig 2 Outline of stem bronchi in 4 cases of operable bronchiogenic cancer. Mrs S B, age 45. Tumor originated in secondary bronchus of right middle lobe and was the smallest growth in the entire series. The lesion produced atelectasis of 1 segment of the middle lobe (Fig 4). Adenocarcinoma, glands not involved. Patient is living and well 1 year and 11 months after right pneumonectomy. Mrs M C, age 59. Tumor originated in left upper lobe bronchus, extended principally into the lumen. An implant of the tumor was found on the medial wall of the main stem bronchus. Carcinoma simplex, glands were not involved, operative recovery, late death from other causes after 7 months. Autopsy failed to reveal evidence of recurrence. Mr R B, age 53. Tumor originated in periphery of right lower lobe but could not be visualized bronchoscopically. Adenocarcinoma, lobectomy, mediastinal glands not involved. Patient is well without evidence of recurrence 1 year and 10 months later. Miss S S, age 53. Tumor originated in lingual branch of left upper lobe and could not be seen bronchoscopically. Adenocarcinoma, diagnosis verified at operation. Patient is now well without evidence of recurrence 1 year and 5 months after left pneumonectomy.

Such patients are considered surgical problems until the question of operability is settled, as excision provides the only hope for cure. Cancer of the lung should and must be considered in the same category. The surgical issue is frequently forced in cancer of the digestive tract by obstruction. Malignant bronchial obstruction does not demand surgical intervention so dramatically, but without its help the lesion that produces the obstruction is, in the end, as fatal as untreated intestinal obstruction due to malignancy.

Surgery versus radiation. Resection of the lung has been of such recent development that the policy of giving radiation a trial even without histological verification is the course too often followed. At the present state of our knowledge

TABLE IV—DURATION OF SURVIVAL AFTER SUCCESSFUL RESECTION OF LUNG FOR
PRIMARY CANCER
Collected Series

Case no.	Surgeon	Age at resection	Pre-operative duration of symptoms	Location of tumor	Lobes involved	Histology	Type of operation	Date of operation	Living without evidence of metastases, last date	Living with metastases, last date	Date of death	Cause of death
	W. E. Adams	33		S	L.U.	Squamous cell	P	Feb. '36	Nov. '36		Nov. '36	General peritonitis, gangrenous appendix
	Idem	43		S	R.M.	Squamous cell	P	Jan. '37	Aug. '39			
3	R. C. Brock	39			L.L.	Oat cell	P	Mar. 20/36	'39			
	H. Brown	40		S	R.M. & L.	Cancer of the lung	L	Nov. '35	Aug. '39			
	A. Crutcher	34	44	P	L.L.	Bronchus epidermoid	L	Nov. '35	Aug. '36	Sept. 26/Oct. '36		Pulmonary hemorrhage
6	Idem	39		P	R.L.	Early cancer	L	Nov. '36	Sept. '39			
7	Idem			P		Epithelioma	L	May '37	Oct. '37		Dec. '37	Recurrent metastases
8	E. D. Churchill	34			R.L.	Bronchus epidermoid	L	Apr. '36	May '39			
	Idem	37	6		L.L.	Bronchus epidermoid	P	Apr. '36			June, '36	Metastases
10	Idem	30	6		R.M.	Bronchus epidermoid	P	May '36	Sept. '36			
11	Idem	46			R.L.	Bronchus epidermoid	L	May '36			June, '35	Cerebral metastases
	Idem	38	14		R.L.	Adenocarcinoma	L	Jan. '36			Apr. '36	Unoperated metastases
13	Idem	43	6		R.L.	Adenocarcinoma	P	Oct., 26/Jan. '36				
14	Idem	38	14		R.M.	Adenocarcinoma	L	July '36	Feb. '39			
	Idem	44			L.L.	Adenocarcinoma	L	Aug. '36			Dec. '36	Cerebral metastases, including hemorrhage
16	Idem	41	6		R.U.	Bronchus epidermoid	P	May '36	Sept., '36			
17	F. S. Dailey and J. C. Jones	46		S	R.L.	Cancer	P	Jan. '37	Aug. '38			
18	Idem	43		S	L.L.	Cancer	P	Jan. '38	Aug. '39			
19	Idem	34		P	R.M.	Cancer	P	May '36	Aug. '39			
20	S. O. Freedlander	40		S	R.L.	Adenocarcinoma	P	Aug. '36	Apr. 27/July '37	Apr. '38		Metastases, 17, metastases to left lung
21	Idem	35		S	L.U.	Adenocarcinoma	P	Feb. '37	Sept. '39			
22	H. K. Gray	43		S	L.U.	Adenocarcinoma grade II	P	Sept., '37	Sept. '39			
23	Idem	46		S	R.L.	Adenocarcinoma grade I	P	Sept. '38			Dec., '38	Metastases to left lung, right suprapubic
24	Idem			S	R.U.	Adenocarcinoma gr. IV	L	May '38	Sept., '39			
25	J. Holst	45		P	U	Cancer	L	Feb. 26/Jan. '39				
26	R. M. Jones	40		P	R.U.	Cancer actively growing	L	Feb. '36			July '36	Cerebral metastases
27	Idem	37		S		Epithelioid cancer	L	July '37	Jan. '39			
28	Idem			S		Anaplastic cancer	L	Oct., '38	Aug. '39			
29	R. Kuntz	48	26	P	R.L.	Epithelioid cancer	Ex.	June, '36	Feb. '39			

TABLE IV—DURATION OF SURVIVAL AFTER SUCCESSFUL RESECTION OF LUNG FOR
PRIMARY CANCER*—Continued
Collected Series

Case no	Surgeon	Age of patient	Pre-operative duration of symptoms mos	Location of tumor	Lobes involved	Histology	Type of operation†	Date of operation	Living without evidence of metastasis last date	Living with metastasis, last date	Date of death	Cause of death
30	R Nissen	69	4	S	R.U	Small cell cancer	L	Dec. '35	Mar '36	?	?	? metastasis
31	W R. Rienhoff	26	18	S		Adenocarcinoma	P	Nov, '33	1939			
32	Idem	69			L		P	Jan '35			Apr '35	Metastasis to brain
33	Idem	44	6	S	L	Squamous cell cancer	P	Mar '35	1939			
34	Idem	47			R U & R.L	Alveolar cell cancer	P	Aug '35			Feb, '36	Metastasis to mediastinum
35	Idem	65	18		R.L	Adenocarcinoma	P	Apr '36			Sept '36	Recurrence in pleural cavity
36	Idem	50	12	S		Adenocarcinoma	P	Dec. '36			1938	Metastasis to right lung
37	Idem	50				Squamous cell cancer	P	Feb '37	1939			
38	Idem	62	4		R.M	Adenocarcinoma	P	Oct. '38			May '39	Coronary thrombosis ? metastasis
39	Idem	58		S	R		P	Oct. '38	1939			
40	Idem	65		S		Squamous cell cancer	P	Mar '37	1939			
41	Idem	45	6	S	R	Squamous cell cancer	P	Apr, '37	1939			
42	Idem	48	6	S	R		P	Nov '37	1939			
43	Idem	50	12	S	R.U	Squamous cell cancer	P	Sept., '38	1939			
44	Idem	64		S	L	Squamous cell cancer	P	Mar '39			Sept '39	Primary cancer of colon not associated with primary cancer of lung
45	Idem	40		S	R.L & M	Squamous cell cancer	P	July, '39	1939			
46	Idem	30		S	R.L & M	Squamous cell cancer	P	July '39	1939			
47	J E. Strode	55		P	L.L	Cancer	P	June '37	Feb '39			
48	J Alexander & C. Haight	39	48	S	R L	Adenocarcinoma	P	Mar '35	Sept., '39			
49	Idem	38	3	S	L U	Squamous cell cancer gr III	P	Sept. '36			Jan., '39	?
50	Idem	55	2	P	L U & L	Medullary cancer grade IV	P	Mar '37			Aug, '37	Pneumonia probable metastasis in spine no autopsy
51	Idem	17	8-12 ?	S	L U	Adenocarcinoma, gr I	P	Apr '37	June, '39			
52	Idem	41	10	S	R.L	Squamous cell grade II	P	Feb '38	Mar '39			
53	Idem	55	4	P	L U	Medullary cancer grade III	P	July '38		May '39		
54	Idem	58	6	S	L U & L	Medullary squamous cell	P	June, '39	Sept. '39			
55	Idem	53	24	P	L.L	Papilliferous cystadenocarcinoma grade II	L	Mar., '37			Nov '37	Recurrence—multiple

TABLE IV—DURATION OF SURVIVAL AFTER SUCCESSFUL RESECTION OF LUNG FOR PRIMARY CANCER—Continued

Collected Series

Case no.	Surgeon	Age of patient	Pre-operative duration of symptoms, mos.	Location of tumor	Lobes involved	Histology	Type of operation	Date of operation	Living without evidence of metastasis, last date	Living with metastasis, last date	Date of death	Cause of death
16	F. L. Chalkin			P	R U	Adenocarcinoma	P	Feb '36			July '36	Primary carcinoma right lung with metastases right chest wall
17	Idem	46	6	S	R M.	Adenocarcinoma	P	Aug. 26 Sept., '36				
18	R. F. Rogers	57	8	S	L L.	Epidermoid cancer	P	July '37 Oct. '36				

Author's Series

Case no.	Surgeon	Age of patient	Pre-operative duration of symptoms, mos.	Location of tumor	Lobes involved	Histology	Type of operation	Date of operation	Living without evidence of metastasis, last date	Living with metastasis, last date	Date of death	Cause of death
	R. H. Overholt	33		S	R U L M.	Cancer unspecified	P	Nov. 23 Sept., '36				
	Idem	43		S	L U.	Cancer simplex	P	May 24 June, '36				
	Idem	39	64	S	L U.	Cancer simplex	P	Aug. '33			Nov. '36	Psychosis, autopsy negative for malignancy
	Idem			S	L U.	Epidermoid cancer	P	May '36 Aug. '36				
1	Idem	36		S	L U. & L.	Oct cell cancer	P	Sept. '36			Feb. '37	Metastases to liver
2	Idem	44	44	S	L U.	Small cell cancer	P	Feb. 23 June, '36				
	Idem	45		S	R M.	Epidermoid cancer	P	June, '36 May, '36				
3	Idem	57		S	R L.	Epidermoid cancer grade II	P	Nov. 27			Jan. '36	Postoperative, no autopsy
	Idem	55		P	R L.	Adenocarcinoma	L	Dec. 27 Sept. '36				
10	Idem	53	15	P	L U.	Adenocarcinoma	P	Apr. '36 Sept. '36				
	Idem	54		P	L U.	Cancer simplex	P	May 26 July '36				
11	Idem	58		P	R M. & L.	Adenocarcinoma	P	Jan. '36 Sept., '36				

All patients showing mediastinal glandular involvement or other evidence of metastatic disease at the time of operation, or patients dying within three months of operation, have not been included.

(Lobes involved: R or L—right or left, U, upper; M, middle; L, lower; P, pneumonectomy; L, lobectomy)

there should be no dispute about recommendations for patients suffering from cancer confined solely to the lung. In a perusal of the literature on the subject I find not a single supporter for the use of either deep roentgen or radium therapy in the so called operable case. Radiologists are in agreement that most primary bronchiogenic tumors are highly radioresistant. The results of

such treatment have been disappointing although there is an occasional rare exception. Cure by radiation has never been claimed. Graham states that he has not been able to find record of a single authenticated 5 year cure. Edwards and Brock and Cann each of whom has had a large experience in the use of intrabronchial radon implantation, do not recommend radiation in any

form for the operable lesion. There is no justification for delaying a decision regarding operability until roentgenotherapy has been tried.

It is beyond the scope of this paper to discuss the management of the inoperable case. However, it has been our experience that not infrequently the ill effects of roentgenotherapy overshadow its benefits. In the presence of superimposed infection, roentgenotherapy often aggravates symptoms and may actually do the patient harm. In 13 patients so treated the average duration of life was 5.6 months, whereas in 26 cases in which no treatment was given, the average survival from diagnosis to death was 8 months. At the present time we are giving radiation only to those inoperable lesions which are causing severe pain and those which do not show evidence of an associated pulmonary suppuration.

Immediate decision regarding operability is essential. In the reported series of cases in which the diagnosis was made during life, the interval between the first symptom and death was relatively short. In the series reported by Jaffé, the period extended approximately 5 months. Koletsky reported 8.9 months, and Frissell and Knox 7.5 months. In our own series, the average interval from the first appearance of symptoms to diagnosis was 11.6 months. It is obvious that time is an important factor. The first steps should be immediate diagnostic tissue verification and evaluation of operability. Both of these steps are surgical. Therefore, carcinoma of the lung is a surgical disease until proved otherwise.

DIAGNOSTIC PROCEDURES

Abnormal physical signs associated with early pulmonary malignancy are either absent or are so variable that they lack significance. The signs in stem bronchus lesions are essentially those of bronchial occlusion or of a superimposed infection. Chest roentgenograms have already been referred to as important in furnishing presumptive evidence. Bronchography may be helpful in cases in which the lesion is beyond the range of bronchoscopic visibility. A bronchial defect may be demonstrated and the relation of the suspicious area to all segments of the lung may be shown more clearly.

Before recommending thoracic exploration for suspected malignancy it is highly desirable that tissue be obtained and the diagnosis verified histologically. Three possible methods of obtaining tissue from the primary lesion are available.

1. *Bronchoscopy* has yielded tissue for biopsy in 72 per cent of all cases examined by this method. Since the majority of lesions are found within the

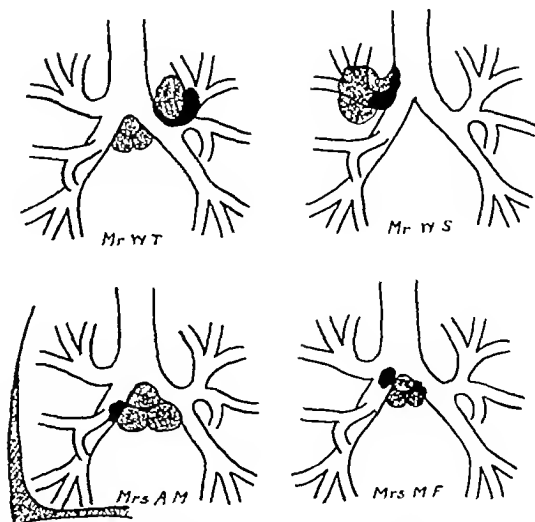


Fig. 3 Outline of stem bronchi in 4 cases of inoperable bronchiogenic cancer. Mr W T, age 41. Carcinoma simplex, grade II, carina widened, fixation left main stem bronchus. Mr W S, age 44. Tumor originated in right upper lobe bronchus with extension up the wall of trachea. Epidermoid, grade II. Mrs A M, age 62. Carcinoma simplex. Originated in medial wall of right lower lobe bronchus, mediastinal gland enlarged, trachea fixed, pleural fluid contained malignant cells. Mrs M F, age 47. Lesion originated in left lower lobe bronchus with extension of growth through to right lower lobe bronchus. Carcinoma simplex.

range of bronchoscopic visibility, this procedure becomes the most important diagnostic method at our disposal. Two other reasons make bronchoscopy invaluable. First, a diagnosis can be made

TABLE V —LATE SURVIVAL AFTER SUCCESSFUL RESECTION OF LUNG FOR PRIMARY CARCINOMA*

Author's and collected cases (Summary of Table 4)
70 patients

	Lobectomy		Pneumonectomy		Total	
	No	Per cent	No	Per cent	No	Per cent
Living	10	56	35	67	45	64
Living with metastasis	0	0	1	2	1	1
Died of metastasis	8	44	11	21	19	27
Died of other causes	0	0	5	10	5	8
Total	18	100	52	100	70	100

*Benign tumors, sarcoma, or metastatic malignancy have not been included. Cases showing mediastinal glandular involvement at operation and patients dying within 3 months of operation have been omitted. Longest survival without evidence of metastasis—5 years and 9 months. 29 patients have lived over 3 years. Average postoperative period of living cases—1 year and 11 months.



Fig. 4. Roentgenogram in early case of primary carcinoma situated in right middle lobe bronchus. The area of density below and lateral to the hilum, as caused by a tumor in segment of the middle lobe. The tumor here was not over the size of a lima bean and failed to cast shadow distinguishable from the electrostatic shadow. See diagram of Mrs. S. B. in Figure 1. Bronchoscopy positive. Leucine-epithelioid carcinoma. Right pneumonectomy performed June, 1937.

earlier by this method than by any other. A lesion too small to occlude the bronchus and produce roentgenographic changes may be seen bronchoscopically. Second, it is by far the safest method of securing a biopsy in stem bronchus lesions (Figs. 1 and 2).

2. *Examination of the sputum for malignant tissue.* When bronchoscopy fails to provide tissue, a careful search of the sputum for malignant cells may be fruitful. Dodgeon and Wrigley and later Barret described a wet-film method which led to a correct diagnosis of pulmonary malignancy in 20 of 26 cases, all verified by autopsy. By using Dodgeon and Wrigley's technique, Dr. W. R. Ruml and Dr. Shields Warren have found malignant cells in the sputum of several proved cases of carcinoma in the author's series. It has not been possible to classify the cells as to type. Although these examinations have been made routinely during the past year, the test has been of practical value to us in only one case. Other times when malignant cells were found in preparations from sputa, the lesions were inoperable or tissue for biopsy had been obtained bronchoscopically. From our experience so far with this method

we are led to believe that the high incidence of diagnostic verification found by Dodgeon and Wrigley was due to the large number of far advanced cases coming under their observation. Whether examination of the sputum for malignant cells will become valuable in the very early cases remains to be determined.

3. *Tissue obtained by thoracentesis and lung puncture.* The experience of Craver and Binkley in aspiration biopsy of lung cancer has recently been published. It is difficult to be convinced that this method is practical in the operable case. A positive aspiration in such a case calls for surgical exploration. A negative aspiration does not disprove cancer and therefore thoracic exploration is also indicated. Needling the tumor transpleurally cannot be devoid of danger as suppuration of the involved lung is a common associated condition. A dissemination of the infection might complicate the situation enough to preclude resection. One patient came to us with an empyema which followed repeated attempts at thoracic aspiration. This complication was a determining factor in the patient's inability to survive pneumonectomy.

EVIDENCES OF INOPERABILITY

Before rendering a verdict of inoperable, one would prefer to have histological confirmation that the growth has invaded tissues outside the lung. This is not possible in many instances. The following criteria for inoperability have been used.

A. *Reflected on bronchoscopic evidence.* (1) Frozen mediastinum as determined bronchoscopically unless fixation is interpreted as being due to previous disease. Widening of the carina, *per se*, is not positive evidence of malignant involvement of glands within the bifurcation. In 2 of our cases a mass of enlarged glands which widened the carina did not contain tumor cells but was inflammatory. It must be admitted however that most patients who show widening of the carina do have inolved mediastinal glands (Fig. 3, Mr. W. T.) (2) tracheal extension which occurred 3 times in our series (Fig. 3, Mr. W. S.) and (3) implantation of growth in contralateral bronchus (1 patient) (Fig. 3, Mrs. M. F.).

B. *Reflected on roentgenographic evidence.* (1) Bilaterally widened mediastinal shadow as shown by roentgenogram with obvious glandular involvement. Unilateral intensified hilar shadow or enlarged hilar glands are found so frequently in operable lesions that they do not necessarily spell inoperability. Usually a paralyzed diaphragm means mediastinal infiltration with involvement of the phrenic nerve. A paralyzed diaphragm was



Fig 5 Roentgenograms in early primary carcinoma involving the left upper lobe bronchus at the point of its division. The lingual branch was completely occluded and other branches partially so. See diagram, Mrs E H in Figure 1. Note emphysematous character of portion of upper lobe with atelectasis of lingual portion shown best

in lateral exposure. The bronchoscopic examination was positive, the biopsy showing carcinoma simplex. Left pneumonectomy was done in May, 1934. Over 5 years after operation was performed the patient is living and well. (From Overholt and Rumel (13). Courtesy of publishers of J. Lancet.)

found in 1 patient coming under observation who died from the effects of pulmonary suppuration. The autopsy showed no involvement of the phrenic nerve by the malignant process. (2) Metastasis to bones, as found in skeletal roentgenograms. Solitary lesions of questionable identity have been biopsied if accessible. In 1 patient surgery was almost denied because of supposed metastasis to a rib. Tumor cells were not found in the biopsied rib. Pneumonectomy was carried out and the patient has lived $5\frac{1}{2}$ years and is still well.

C. Rejected on discovery of distal malignant cells elsewhere. (1) Cervical glands positive on biopsy, (2) malignant cells in aspirated pleural fluid. Usually pleural effusion develops in the later stages and is a bad omen (Fig 3, Mrs A M). Pleural fluid was found in but 1 operable case in our series, and (3) pleural metastasis demonstrated by thorascopic examination. It is significant that the operability rate in this series has been higher than in any other reported series of cases, yet the average duration of symptoms is longer. The duration of the first symptom to diagnosis was 15.6 months in the operable group, and 11.5 months in the entire series. This emphasizes the

importance of a thoracic surgical evaluation of operability.

It is frequently difficult to appraise the patient's general condition due to constitutional effects of an associated infection in the lung. Prolonged fever and weakness resulting from pulmonary suppuration need not necessarily contra-indicate operation. Frequently, improvement can be effected by bronchoscopic dilatation and improved internal drainage. Gradual deflation of the lung by a preliminary period of pneumothorax may greatly enhance a patient's chance of withstanding pneumonectomy. It must be remembered that the excision of tumor also removes the septic reservoir entirely, thereby ridding the host of both conditions.

However, some patients may also be considered inoperable on the basis of insufficient pulmonary reserve. A small tumor producing a "ball-valve" effect in a stem bronchus may reduce the vital capacity to the point of dyspnea at rest. Emphysema of an entire lung is not tolerated as well as the loss of the lung itself. Periodic dyspnea due to bronchospasm induced by the irritation of the tumor may also be misleading in an appraisal of ability to tolerate pneumonectomy.



Fig. 6. Roentgenogram of chest (Mrs. E. H.) 5 years and 1 month after left pneumonectomy. Note density and dimpled area of left hemithorax. Thoracoplasty as not performed. (Overholt (). Courtesy of publishers of J. Connecticut State Medical Society.)

RESULTS OF CLINICAL EXAMINATION AND DISPOSITION OF CASES

During the past 6 years 104 patients have been studied in whom a diagnosis of primary malignant

cy of the lung has been made. Fifty-one or practically one-half of the total number were free of clinical evidence of metastasis when coming under observation. One patient was treated by bronchoscopic fulguration; 2 patients refused thoracic exploration; 48 patients were explored and 21 were found suitable for resection. This places the operability rate at 21 per cent for the entire group which includes both verified and suspected cases. Operability in the group verified histologically even including those in whom the disease was determined for the first time at autopsy was 27 per cent.

In Table I certain data concerning the entire group is summarized. It seems encouraging that it was possible during life to obtain tissue for histological verification in 92 per cent of the verified group and in 72 per cent of the entire group. Tissue was not obtained until after death in 6 cases and the disease was suspected in 4 of these. Two patients, 1 with brain tumor and 1 with pericardial invasion died after presenting symptoms referable only to metastatic disease. Our experience, therefore, is much more encouraging than that of Hochberg and Lederer who state that 17 per cent of their patients came under observation with initial symptoms attributable to metastatic disease.

In Table II are summarized the results of thoracic exploration in 52 patients in whom



Fig. 7. Photograph of Mrs. E. H. now age 50. Left pneumonectomy as performed in May, 1934, for carcinoma simplex involving left upper lobe bronchus (Figs. 5, and 6). When examined on June 8, 1939, patient reported that she is symptom free since leaving the hospital, had not spent a day in bed because of illness, and is doing all her own housework. Note lack of deformity and general state of nutrition. (Overholt (). Courtesy of publishers of J. Connecticut State Medical Society.)

primary malignancy was suspected or verified. There were 26 patients in each group. In 13 of the verified cases exploration revealed extrapulmonary extension and the operation was concluded. In 1 other patient mediastinal involvement was determined after resection. Operability in the verified group was therefore 46 per cent rather than 50 per cent. Fourteen patients in the unverified group were considered unsuitable for resection after exposure of the hilum and mediastinum. In 7 instances it was possible to obtain tissue from the lung or mediastinum for diagnostic confirmation. In an equal number it was considered unsafe to remove tissue for microscopic study. These patients remain in the unverified group.

One of the most difficult problems confronting the thoracic surgeon presents itself during exploration in cases of suspected malignancy when one's decision regarding pneumonectomy is not fortified by previous tissue diagnosis. This situation arises chiefly in regard to the peripheral type of neoplasm. It has been considered safer to rely upon clinical features, gross appearance, and palpation rather than to resort to biopsy of the primary lesion during exploration. Pneumonectomy or even attempts at aspiration are likely to result in contamination of the hemithoracic space and mediastinum which is a complication definitely to be avoided in the safe performance of pneumonectomy. In 8 instances a lobe or an entire lung was removed on presumptive evidence alone and carcinoma was found in all removed specimens. In exploring the chests of 4 patients in whom a presumptive diagnosis of carcinoma had been made, other conditions were found and corrective surgical treatment was given. Two cases of extensive pulmonary suppuration, thought to be engrafted upon a malignant process, were successfully treated by pneumonectomy. One patient who developed a dry irritative cough with attacks of hemoptysis was found to have a solitary mass in the mid-lung field resembling a peripheral type of neoplasm. Exploration revealed a deeply situated interlobar empyema which healed following drainage. Another patient had chronic cough, pulmonary hemorrhages, and an atelectatic upper lobe, which developed sometime after a streptococcus sore throat and pneumonia. The roentgenogram was typically that of a stem bronchus carcinoma with upper lobe atelectasis. Exploration revealed evidences of a postinflammatory fibrosis of the upper lobe with constriction at the hilum. Mobilization of the upper lobe and release of scar above the hilum was followed by a disappearance of all symptoms and a re-expansion of the lobe.

Eleven of the 17 patients treated by pneumonectomy and 3 of the 4 treated by lobectomy survived the operation. Two of the latter have since died of recurrences. Both of these patients were treated early in our experience, and pneumonectomy would have been the procedure selected for them if they had come under observation at a later time. One patient treated by lobectomy is still living without evidence of recurrence 1 year and 8 months since the operation.

Survival rates among the group treated by pneumonectomy have been better. One patient died of recurrence 4 months after operation and 2 other patients have since died but not of cancer. In 1 patient autopsy failed to reveal any trace of recurrence. Another patient was examined 10 months after operation and no evidence of recurrence was discernible, but a few weeks later pneumonia developed which terminated fatally. Postmortem examination was not done.

Survival rates do not necessarily tell the whole story nor does the percentage of cases accepted for surgical treatment. A theoretical cure rate for this group was computed by subtracting all those cases subsequently shown to have had metastasis, whether manifest at operation or not, and by adding operative deaths in which it was shown at autopsy that metastatic disease was not present. This computation is shown in Table III. It has been found that 14 per cent of the total number of cases did not have extension of the growth beyond the lung at the time surgical treatment was instituted.

Nine patients, 1 a lobectomy case and 8 pneumonectomies, who once suffered from primary malignancy of the lung, are now living and well without evidence of recurrence. Activities have not been restricted and all but 2 patients are carrying on with the same work previously done. Two patients have passed the 5 year mark and another is in his fourth year (Figs 5, 6, 7, and Table IV).

The rather low incidence of recurrence in those patients surviving pneumonectomy seems definitely encouraging. Since insufficient time has elapsed for the experience of any one individual to reach significant proportions, all surgeons who have reported on the successful performance of pneumonectomy for carcinoma were sent a questionnaire concerning follow-up data. The questionnaire was answered by 23 surgeons. The collected data on reported and personal cases are shown in Tables IV and V. The questionnaire related only to patients who were free from mediastinal glandular involvement or other evidences of extrapulmonary extension at the time of

operation, and to those who survived for more than 3 months after operation. A total of 58 cases was included in the responses to the questionnaire. Summarizing collected data and our own experience, we found that 45 of a total of 70 patients are still living and free of disease. Nine teen patients succumbed to metastatic disease. In 5 patients death was reported to be due to other causes. Of the 19 who died of metastatic disease, 8 followed lobectomy. It is significant that in the pneumonectomy group of 52 cases, only 11 patients have since died of recurrence. The survey reveals that 64 per cent of all patients who were treated before the advent of metastasis and who survived operation have continued to live for variable periods of time up to 5½ years without evidence of recurrence.

SUMMARY

1. The medical profession should become interested in primary carcinoma of the lung, first because it is a common disease, and second because curative treatment is available to those whose disease is still local in its extent.

2. An optimistic attitude as to the future seems justified for the following reasons: (a) Early warning symptoms do occur in the majority of cases (b) early lesions may be suspected after roentgenographic examination, as the lung fields lend themselves well to contrasting shadows either of the tumor or of atelectasis (c) three-fourths of all primary lung tumors are situated in the stem bronchi, and are therefore accessible to bronchoscopic visualization and biopsy.

3. In a period shorter than a decade of surgical treatment, operability has surpassed that of the esophagus and possibly the stomach. In a series of 71 cases, 31 per cent of the lesions were considered resectable and surgical treatment was carried out. The theoretical cure rate in this series

of patients has been computed to be 14 per cent. Eleven per cent of the verified cases have lived following surgical resection for varying periods of time up to 5 years and 10 months without evidence of recurrence.

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POSTOPERATIVE PULMONARY COMPLICATIONS

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THE appraisal of surgery by its final attainments has long claimed the attention of the American College of Surgeons. To this body should go much of the credit for the improvement of surgery in this country, through constantly stressing the value of end-result studies. Evaluation of statistical data obtained in this manner has called attention to sequelæ and complications which so often mark the difference between success and failure of an operation. All this has led to more intelligent efforts to reduce these complications by better pre-operative preparation, improvements in anesthetics and their administration, meticulous care in the elimination of operative trauma, and closer attention to the patient throughout the convalescent period.

Of all the complications which beset the surgeon, those involving the lungs are among the most common, the morbidity from this cause alone is about 3 per cent. This in itself is serious enough but is even more alarming when one realizes that about 40 per cent of those patients die. In operations upon the upper abdomen the morbidity for serious pulmonary sequelæ is about 10 per cent. Consequences of so frequent and serious a nature demand the efforts of all surgeons in bringing about methods for their prevention and cure.

Etiology. Numerous etiologic factors have been proposed to account for pulmonary lesions which follow operation, and it is probable that any of these, or a combination of them, is responsible. The 2 most commonly supported views, and the 2 causing most controversy are (1) that anesthesia, with aspiration of infected material, is the cause of most pulmonary complications, and (2) that emboli, either sterile or infected, are responsible. Other factors, such as decreased respiratory excursions, abolition of the cough reflex, and a lowered resistance must be considered.

The embolic theory, which Cutler has ably advocated and frequently emphasized, is based upon well established clinical and experimental evidence. With every wound thrombosis inevitably occurs as a natural phenomenon. That thrombi sometime break off and reach the lung is to be expected. Frequently they are so small or few in

number that no symptoms result. When larger emboli block the pulmonary circulation infarction occurs, and upon the size and number of the emboli and upon the amount and virulence of infected material carried with it will depend the extent and nature of the pulmonary disorder.

The fact that pulmonary complications follow operations performed under local anesthesia with almost the same frequency as those done under general anesthesia, is additional evidence of the rôle of infarction as an etiologic agent. Moreover, the experimental production of pulmonary lesions by infarction is easily accomplished, while the production of pneumonia by the bronchial route is notoriously difficult. Since large amounts of infected material are aspirated with every operation under general anesthesia, it would be logical to expect a greater percentage of lung infections if this were the means by which the infection is produced. The abrupt onset in most pulmonary lesions, particularly those that occur 8 or 10 days after operation, point to the embolic nature of the disease, and the same pathogenic bacteria can be found frequently in a lung abscess as is present in a septic wound elsewhere in the body. Thus it is seen that there is a sound and logical basis for those who believe that wound trauma, and that alone, is responsible for postoperative pulmonary complications.

On the other hand, there is no doubt that infected material from the mouth and throat, as well as blood and vomitus, is drawn into the lungs of anesthetized patients. Bacteria thus implanted may be the cause of varying reactions in the lungs, this depends upon such factors as the virulence of the organism and the resistance of the host.

Whipple found the pneumococcus as the most common inciting factor in postoperative pneumonia and type IV of this organism was most frequently found in the sputum. Lately Sutcliffe and Steele have confirmed these findings of a predominance of the pneumococcus in cases of postoperative lung complications and stressed the apparent relationship of pulmonary changes to the pharyngeal flora. They found that "three patients without pathogenic organisms in the pharynx before or after operation had the least lung changes," but in "thirteen patients with pathogenic organisms in the pharynx, eleven had postoperative pulmonary changes greater than the

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minimum. The findings of these and many other investigators indicate the importance of nasal and pharyngeal infection as a source of postoperative pulmonary complications.

The role of atelectasis in the production of postoperative lung complications is undoubtedly a large one and it has been claimed that this lesion is the basis of these disorders. Following abdominal operations, particularly high incisions, the absence of deep diaphragmatic breathing rapidly brings about absorption of the alveolar air and collapse of the lower lobes. Thus a high, fixed diaphragm is a frequent finding after operation. Limitation of respiration by position or by tight abdominal binders and abolition of the cough reflex likewise predispose to atelectasis. The accumulation of mucus and failure to expectorate it are hastened by these conditions, and plugging of the bronchi with subsequent absorption of alveolar air results. While atelectasis may not be a precursor of pneumonia in all cases, the stage is set for invasion of the lung by bacteria, and infection of varying degrees usually follows. This is further influenced by those factors which tend to lessen the patient's resistance, such as rapid and extensive changes in temperature.

While either aspiration emboli or atelectasis may appear to be the predominating factor in the production of postoperative pulmonary complications, it is likely that there is an interrelation between the two or more causative agents.

Symptoms and physical signs. Regardless of the etiology, postoperative lung disorders bear a striking similarity in their mode of onset and physical characteristics. Usually within 48 hours there is a rapid rise of temperature to 101 or 102 degrees with increased pulse and respiration. Subjective symptoms are noticeably absent which account for the frequent failures of diagnosis. Usually the only complaint is a painful cough malaise, and a feeling of catching cold. Occasionally the onset is accompanied by pain in the chest and the expectoration of bloody or rusty sputum.

At first the physical signs may be limited to the finding of rales at the lung bases, without evidence of consolidation, and a diagnosis of bronchitis is made. Roentgenograms usually show only some elevation of the diaphragm due to hypoventilation (3). This condition which is alarming largely because of the temperature rise, usually subsides in 24 hours.

However the process may progress with a further rise in temperature, pulse and respiration. An area of consolidation appears, usually in one of the lower lobes, and is confirmed by the roent-

genographic shadow which is often wedge-shaped. The physical findings are those of lobular pneumonia: dullness, tubular breathing, and increased fremitus. Symptoms subside gradually and the temperature falls by lysis, usually within 3 or 4 days. This is the usual course but the infection may spread throughout one lung or even to the other side, and it is in cases of this type that death is most apt to occur. Likewise infection may be of such a type, particularly if infarction is present, as to lead to abscess of the lung or gangrene. These latter conditions are but a continuation of the infectious process and are to be looked for if the cough becomes more persistent and the temperature continues beyond the time expected in ordinary bronchopneumonia. Here again roentgenograms are of the greatest value in diagnosis.

While some degree of atelectasis probably exists in most lung complications, massive collapse of a lobe or even an entire lung must be considered as a pathological entity and should not be confused with pneumonia or pleural effusion. The symptoms and physical findings are variable and depend upon the extent of lung involvement. The onset is usually sudden, 48 to 72 hours after operation. There may be pain in the chest, shortness of breath, cyanosis, and a rapid rise in temperature, pulse and respiration. The patient appears frightened, anxious, and acutely ill, or the symptoms may be so mild that the condition is not detected unless the chest is examined. The collapsed lung is dull to percussion, the breath sounds are diminished or absent, and the mediastinal organs are displaced toward the side of the lesion. The roentgenograms will assist greatly in the diagnosis, especially in those patients with incomplete deflation. The intercostal narrowing over the affected area can be compared to the normal side, and the displacement of the heart and trachea and the elevation of the diaphragm can be seen clearly.

TREATMENT

Treatment is largely directed toward prevention and elimination of the predisposing factors which lead to pulmonary complications. In general, prophylactic measures are intended (1) to prevent the infection of the lung by bacteria, (2) to minimize the circulation of emboli and their implantation in the lung, (3) to prevent atelectasis, and (4) to minimize shock or other factors whose depressing effect lowers the resistance of the patient.

Inflammation of the upper respiratory tract undoubtedly is a predisposing factor and no operation, save that of emergency, should be done in the presence of infection in the pharynx or nasal

passages Operation should be postponed for at least 2 weeks where there are symptoms or a recent history of coryza, tonsillitis, or bronchitis If emergency operations are performed under such unfavorable conditions, nitrous oxide or cyclopropane is preferable to ether because they are less irritating to the bronchial mucosa

The dissemination of emboli can in a large measure be prevented by careful operative technique and postoperative care Defects in technical surgery, such as mass ligation and strangulation of tissue, the use of large ligatures, and resultant infection, predispose to the breaking off of thrombi and their lodgement in the lungs

While the exact cause of atelectasis has not been determined indisputably, obstruction of a bronchus by a mucous plug plays an important, even if a secondary, rôle in its production Diminished respiration and diminished ventilation with accumulation of bronchial secretions should be reduced where possible Long periods of narcosis after operation should be avoided, and deep breathing, coughing, and expectoration of bronchial secretions should be encouraged as soon as possible The inhalation of 5 to 10 per cent carbon dioxide in oxygen at the end of operation and 2 or 3 times daily in the immediate convalescent period is the best stimulant to deep respiration Abdominal binders should not be so tight as to inhibit respiration and the patient's position should be frequently changed to prevent hypoventilation Opiates should be given in sufficient amounts to allay the pain of coughing During the operation and immediately thereafter Gray advocated the Trendelenburg position in order to favor the gravitation of secretions from the lungs Should atelectasis develop, the patient should be rolled back

and forth on the uninvolved side (4) and encouraged to cough

Should definite pneumonia develop, whether as a sequel of bronchitis, infarction, or atelectasis, the treatment is no different from that uncomplicated by operation The use of oxygen, sulfapyradine and other chemical and biological agents should be prescribed as indicated

Measures should always be taken to avoid exposure of the patient to sudden changes in temperature, particularly to cold and chilling Shock from the trauma of operation and loss of blood should be minimized where possible and blood loss should be replaced by transfusion Where circulatory failure from cardiac disability supervenes or is suspected, measures to correct it by digitalization should be carried out It is emphasized again that pulmonary complications are the all too frequent sequelæ of operations, but proper preparation of patients and careful attention to the technical performance of operations will go far in eliminating them

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RELATIONSHIP OF BRONCHOSCOPY TO SURGERY OF THE RESPIRATORY TRACT

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IN dealing with bronchoscopy in its relation to thoracic surgery I wish to advance the thesis that the 2 are as closely related as are, for instance, cystoscopy and genito-urinary surgery. The bronchoscope, of course, cannot take the place of surgery. It must be regarded merely as an instrument for more precise diagnosis and at times an aid in treatment.

If one bears in mind that the symptoms of most of the pulmonary diseases are much the same as are also the physical signs and roentgenographic appearances, it will be seen that differential diagnosis is urgent and the importance of a direct inspection of the tracheobronchial tree will be understood at once.

No discussion of thoracic disease is complete without consideration of foreign bodies in the food or air passages. As is known, foreign bodies in the tracheobronchial tree or esophagus, especially in their secondary effects, may produce the symptoms of any known pulmonary disease. They are especially to be remembered in connection with lung abscess. Since history, physical examination, and roentgenograms may all be negative in lung suppuration as to the presence of a foreign body although such an object is present, a bronchoscopy is always indicated. In a large majority of instances the correct diagnosis will be made and removal will then follow. This will probably cure the patient. If it does not, the proper surgical procedure can then be adopted. Drainage of a lung abscess will never be successful as long as the foreign body remains.

Another use of the bronchoscope in connection with lung suppuration is localization. In roentgenograms the shadows of the lobes overlap one another. I am quite aware that oblique and transverse films have greatly improved roentgenographic diagnosis since the days when only anteroposterior films were taken. Still in connection with small suppurations, even the best of films are at times uncertain. Then the tracing of the pus to its point of origin may exactly localize the trouble. Need I point out how such localization simplifies the task of the surgeon?

Localization may be aided further by the injection of lipiodol through the bronchoscope. Ordinarily lipiodol is placed by successfully dropping it through the larynx with the syringe. If it is desirable, however, to get just the right amount in the right place, no method is more successful than the use of the bronchoscope.

Another assistance which the bronchoscopist may render is that of preliminary drainage. Many abscesses of the lung recover spontaneously with medical treatment and postural drainage. A certain number again, unimproved by these measures, will recover as soon as regular bronchoscopic treatments are instituted. There are, however, many patients with lung abscesses who will need external surgical drainage for their cure, no matter how faithfully the medical treatment and bronchoscopic drainage are carried out.

The internal drainage in these patients may be so poor that the individual is septic, racked by pain, and in such depressed condition as to be a poor surgical risk. At such times then bronchoscopic drainage, repeated a few times, will relieve the septic condition and so improve the general condition of the patient as to make successful surgery possible. This is so particularly in the acute stage of lung abscess. As is known there is always necessity for surgical delay in the acute stage of lung abscess. Every patient should be bronchoscoped at once when the diagnosis is made. There are 2 purposes in this, first, to rule out a foreign body or other aspirated material and second, to establish immediate drainage. The ruling out of a possible foreign body and its immediate removal, if found, need not be enlarged upon.

The beneficial effects of prompt aspiration early in the evolution of a lung abscess is not so well understood. Following such operations as a tonsillectomy or other operations about the mouth, it has been noted by many authors that prompt recovery from the abscess often follows even a bronchoscopy. The explanation may be as follows. Such abscesses are most frequently due to aspiration of foreign material, either blood, vomitus, or bits of tonsils. I myself have removed a bit of tonsil, microscopically proved, from the lung of a patient with lung abscess following tonsillectomy. Many other such cases must occur

As a rule this question can be answered. For example, the neoplasm may be below the mouth of the upper lobe bronchus. Then if the carina is not distorted and the proximal tube is flexible, one may conclude that the upper part of the bronchus and the hilar glands are not involved. Under such conditions a suitable stump may be secured. An endoscopy certainly should always be done before a lobectomy is started. For example the film of a man of 60 who was thought to have a malignant tumor in the left upper lobe, suggested that this would be a good case for lobectomy judged from the peripheral position. The bronchoscopy however showed a large mass in the main bronchus. Here a total pneumonectomy was called for.

Another field for the collaboration of endoscopist and thoracic surgeon is tuberculosis. Even so simple a procedure as a pneumothorax frequently calls for a previous bronchoscopy. At times the collapse of the seemingly diseased lung is followed by the disappointment of a continued positive sputum. A bronchoscopy may show extensive bronchial disease on the other side. It may be said, too, that the bronchoscopist is prepared to correct, to a great extent, tuberculous lesions of the bronchi which may render operation unsafe.

Endoscopic inspection reveals an astonishing number of ulcers, tumors, and strictures in tuberculous patients. Surely a thoracic surgeon before an extensive thoracoplasty for example

should know the condition of the trachea and bronchi. Let us suppose that an operation is planned for the closure of cavities full of pus. It should be known that the bronchi leading from such cavities are open and that they will give free drainage after the operation.

The bronchoscopist is prepared to offer some thing after as well as before operation. All surgeons no doubt have had bad moments when a weakened patient, unable to clear his lungs, seemed almost drowning in his own secretions. At such times a bronchoscopic aspiration will be life saving. It seems to me that every service for thoracic surgery should be prepared to perform postoperative aspiration when necessary.

One more thing I might mention. A double bronchoscope has been devised through which it is possible to separate the air from the 2 lungs. This makes it possible, for instance to estimate the capacity of the one lung to carry on when it is proposed to remove the other. I know this has been presented to the Society for Thoracic Surgery yet it never seems to have aroused interest.

It will be seen then from these remarks that the bronchoscope offers the thoracic surgeon possibilities of accurate localization of intrapulmonary disease: the taking of biopsies, the placing of Epiodol, and general and local drainage, either before or after operation and I have tried to point out the specific application of the bronchoscope to the various pulmonary diseases.

PRINCIPLES IN THE TREATMENT OF EMPYEMA

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THE fundamental principles in the treatment of acute empyema of the pleural space are often eclipsed by details of minor importance. Articles appearing on this subject are misleading when they attribute good results to a single point and fail to emphasize the adherence to principles. Details in securing a favorable outcome cannot be overlooked but their importance must be secondary to fundamentals. An important principle is to avoid open pneumothorax early in the course of the disease. To ignore it increases mortality. There is much experimental and clinical proof that increased pressure in one pleural cavity is reflected in the pressure of that on the opposite side. Graham and Bell working on the empyema commission during the World War stressed this point and showed that the mediastinum cannot be regarded as a fixed partition. Whatever occurs to change this pressure, such as disease from within or operative procedures on the chest wall allowing an open pneumothorax to develop, may cause embarrassment to the respiration and circulation through its increased pressure in the side operated upon as well as a transmitted increased pressure to the sound side.

Empyema is a complication and not a disease. Because it is a complication, the primary disease must be taken into account. The streptococcus, the pneumococcus, and the anaerobes are the common organisms encountered. One may become suspicious of the development of an empyema when the fever subsides and then rises again. This is more often true in the pneumococcic type, which forms more slowly and gives evidence of its presence when the symptoms and signs of the process within the lung are subsiding. In the streptococcic form the process forms simultaneously with the pneumonic process and the accumulation is very rapid in some instances. In children the pneumococcic type may occur along with the primary disease and simulates the streptococcic form. The pus aspirated early in a streptococcic empyema is thin, sometimes turbid or serosanguineous and contains little fibrin. This pus becomes thicker rather slowly, in some in-

stances it takes a period of a couple of weeks. This is in contrast to the pneumococcic form in which the pus is usually thick, fibrinous, and abundant at the time the diagnosis is made. The latter, therefore, exists more in the nature of a walled off abscess, whereas the former may involve the entire pleural surface early in its course. The marked absorptive surface of the pleura in these cases is one factor in the toxemia sometimes observed. These facts have their application in the choice of procedure in a given case.

There are 2 objectives in the treatment of an empyema. The first is to establish adequate drainage, the second is to obliterate the cavity. No case can be assured of a good end-result without their fulfillment.

However, before the establishment of drainage it is well to consider the individual factors in the case. The immediate need may call for relief from a constant cough due to pressure which with delay might rupture into a bronchus. Embarrassment both to respiration and circulation from large accumulations of pus may occur, or the overwhelming signs of sepsis in highly virulent infections may be present. This relief may usually be accomplished to a degree by aspiration of some of the pus. The magnitude of an operation in any field often governs the risk involved. By the same token, the least possible procedure may be sufficient to improve the condition of the patient in order to make subsequent procedures safer. It is with this in view that aspiration of purulent material serves its greatest usefulness. A lower temperature and decreased respiratory and pulse rate usually follow. In some instances of mild virulence or small pockets it may be sufficient to cause symptoms and signs to disappear.

Adequate drainage, however, is usually accomplished by either the closed or open method. The difference in the 2 methods lies in the fact that the closed method attempts to avoid an open pneumothorax with its danger of increased intrapleural pressure. In a well walled off abscess this danger does not exist. We presume the presence of adhesions when the pus is thick, but this presumption allows for an error in judgment. Therefore, it does seem that preference for the closed method of drainage adds a margin of safety. Whenever the pus is thin and sepsis makes adequate drainage desirable, the closed method is

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imperative. It is in this type in which the parietal and visceral pleurae have not yet become adherent, that the mediastinum may be mobile and the collapse of the lung may result if a portion of a rib is resected and an open pneumothorax develops. It is also likely in this type that the pneumonia may still exist and the toxemia attendant upon it does not safely permit the added burden created by an open pneumothorax too early in the disease. It is here then that the primary disease must be reckoned with in the choice of procedure. The ease with which a tube is inserted under local anesthesia without moving the patient is a worthwhile consideration when the patient shows the effects of prolonged or virulent infection. Closed drainage is not an attempt to avoid a rib resection, although that, too may be accomplished. It is merely a method to provide adequate drainage without an open pneumothorax in any case but particularly in those in which pneumothorax increases the risk of morbidity and mortality.

Open drainage accomplished by the resection of a segment of one or more ribs is likewise adequate. When done at the proper time it gives equally good results. Any number of series of cases are reported by as many authors whose results compare favorably no matter what method is used. However these enviable results include the recognition of fundamentals.

Once adequate drainage is obtained it is of equal importance that it be maintained lest the signs of sepsis reappear. In closed or open drainage this is best accomplished by the introduction of solutions, such as normal saline or chlorine preparations, into the pleural cavity and provision should then be made for their removal. Tidal irrigations and many other means have been suggested to accomplish this. Their value cannot be overlooked. The washing and removal of necrotic material and fibrin, which otherwise might organize and encapsulate organisms will undoubtedly decrease recurrences. The sterilization of the cavity is demonstrated by cultures made from the washings.

The second chief objective is the obliteration of the cavity. The mechanism by which this is accomplished is an obliterative pleuritis. This process is sometimes observed in patients undergoing artificial pneumothorax treatment for pulmonary tuberculosis. A pleurisy develops followed by the formation of fluid. Adhesions between the parietal and visceral pleura may then take place and this becomes a creeping process in which the lung gradually re-expands and nullifies the effectiveness of the treatment. So, too in the inflamma-

tory process of an empyema, once the adhesions are established the contraction of these adhesions gradually progresses. Besides this there is the inherent tendency of the lung to expand, a displaced mediastinum to return to its normal position, and a depressed diaphragm to elevate. Factors which play a part in hastening this objective are adequate drainage, solvent action of irrigations on a thickened visceral pleura, maintenance of a degree of negative tension in the pleural cavity and increase of intrabronchial pressure. Not all cases re-expand with the same rapidity nor are all aided by the same measures or any measures devised for hastening this re-expansion. The size of the pocket, the type of infection, the time of drainage, the condition of the patient, and the presence of a bronchial fistula influence re-expansion of the lung.

The obliteration of the pleural space is a gradual process and in closed drainage is demonstrated when fluid will no longer enter the cavity provided that the reduction in size has been progressive. It also is more conclusively visualized by filling the cavity with an opaque solution from time to time and by obtaining roentgenographic evidence as to the size and shape. In open drainage the cavity properly cured for can be visualized directly and its progress observed.

Interlobar mediastinal, or diaphragmatic collections of pus are best treated as abscesses. As such, open drainage is indicated in order to determine the presence of adhesions and thus enter the abscess without its dissemination to a clean, pleural space. Soling of the pleural cavity in instances in which the infection is virulent or caused by anaerobes is very serious.

The importance of dependent drainage has been overemphasized. It has led to injuries of the diaphragm and peritonitis. The eighth or ninth interspace in the posterior axillary line in the common posterolateral empyema is sufficiently low. In adequately drained empyemas, which are opened for the obliteration of a residual cavity the cavity lies almost invariably above the sinus thus indicating that drainage at this point has accomplished its purpose.

The treatment of tuberculous empyema is a subject in itself. Any patient with pus in the pleural cavity and a history of insidious onset should be suspected of having sterile pus. The treatment here is not drainage and the difficulties encountered in caring for those in whom it occurs warrant the routine procedure of smear and culture prior to instituting drainage. The smear does not always reveal organisms even in pyogenic cases but the culture media will. It is always

necessary, however, to use anerobic as well as aerobic culture media in order not to obtain a report of no growth

Hedblom once wrote "The course and outcome of an empyema is determined not only by treatment but also by type and virulence of infection, pathologic anatomy, age and general condition of the patient, and the nature and gravity of the primary infection of which it is almost always a complication"

I have purposely refrained from suggesting various means of accomplishing some of the objectives which to me seem important, but have

endeavored rather to adhere to the underlying fundamental principles which should guide us in our method of procedure in the treatment of this disease

In spite of our best efforts there are some patients who will succumb This occurs when empyema is only one of the complications which attend a generalized infection, such as pericarditis, peritonitis, or meningitis Nevertheless, as we individualize the treatment of empyema and adhere to accepted principles, we will lower the mortality, lessen recurrence, and reduce chronicity

OBSTETRICS AND GYNECOLOGY

PROPHYLAXIS AND TREATMENT OF CARCINOMA OF THE CERVIX AND BODY OF THE UTERUS

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IT is impossible, because of space limitations, to do more than just touch upon some of the essential features of so broad a subject as carcinoma of the cervix and endometrium; moreover there have been no spectacular advances in our general knowledge of cancer during the past year. The fact remains, however, that a great deal of cancer of the cervix can be prevented and a great many cases of established cancer can be cured through the application of our presently imperfect methods of prophylaxis and treatment.

CANCER OF THE CERVIX

Prophylaxis. In spite of all that has been written and said concerning the prophylaxis and early diagnosis of cancer of the cervix, the status of most of the patients referred for treatment is as bad as it was many years ago. Formerly or roughly speaking before 1925, most of our patients were first seen in a hopelessly advanced stage because of the Victorian prudery of that period. In simple words, it was the fault of the patient. Today however thanks to the publicity given the subject most women are informed of the suggestive symptoms of cancer of the cervix and ask for examination promptly upon the appearance of such symptoms and an ever increasing number report for a semi-annual examination in the absence of symptoms. In spite of this, the incredible apathy of the profession at large toward prophylaxis and the quite simple technique of the recognition of early cancer of the cervix have resulted in a general failure to accord the patient the adequate examination which she deserves. In other words, it is now the fault of the profession at large that the incidence and mortality rates of cancer of the cervix show little improvement.

There are only symptoms suggestive of early cancer of the cervix or corpus uteri: the appearance of discharge or of bleeding independent of menstruation. Either of these should promptly

cause the patient to seek competent examination. From the doctor's point of view the most important factor in the problem of cancer of the cervix is that there are a very common and easily recognized benign lesions which are definite forerunners of most cases of cancer of the visible portion of the cervix. These are heteroplasia and leucoplasia. Heteroplasia consists of the replacement of normal squamous epithelium by an outgrowth of cylindric-cell epithelium of the type normally present only within the cervical canal. There are 2 types: the spontaneous variety generally called erosion or ectropion—a more correctly descriptive name for the condition is ectropion,⁴ since the process is one of outgrowth rather than excoriation or out turning—and the variety known as eversion, which is caused by the healing-over of the raw surfaces of a laceration by cylindric-cell epithelium instead of the more resistant and appropriate squamous type. Leucoplasia, roughly speaking, consists of a localized keratoid change in the mucosa with diminution of the cellular glycogen content, which is recognized by its comparative pallor and by its failure to show staining upon the application of iodine. Fortunately, the vast majority of heteroplasias and leucoplasias fail to eventuate in malignancy yet most cancers of the visible areas of the cervix have their origin at the edge of a heteroplasia or in a leucoplastic lesion.

A thoroughly competent gynecologist is able usually to determine by gross inspection whether he is dealing with a benign heteroplasia or with an early cancer but if there is any doubt, or if the lesion bleeds upon gentle trauma, the competent gynecologist immediately resorts to biopsy for a definite microscopic diagnosis. This very simple procedure is harmless to the patient and is available to every practitioner who possesses a speculum and a knife. Biopsy is best done with a sharp pinch forceps capable of removing about a cubic centimeter of tissue and should be followed by actual cauterization of the raw surfaces to control bleeding and to seal the opened tissue

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spaces. However, biopsy may be done safely with a minimum of equipment. The whole procedure including cauterization is infinitely less painful than the filling of a dental cavity and requires no anesthetic. If the lesion under investigation is benign, simple destruction of the abnormal tissue with the cautery, which is best done at a single sitting rather than as a series of partial cauterizations, practically always results in a permanent cure and requires no anesthesia except in the case of very extensive eversion or ectropion in sensitive individuals. The efficiency of the adequate treatment of heteroplasia as a prophylaxis against cancer is indicated by the report of 1 clinic in which only 1 case of cancer developed in over 2,000 adequately treated cases of heteroplasia, whereas 19 cases of cancer occurred in 187 cases of untreated, advanced heteroplasia. From the patient's point of view the universal application of the principle of biopsy in all doubtful cases would result in a great deal of unnecessary discomfort and expense, since it is not possible for everyone to be a thoroughly competent gynecologist, yet these are trivial considerations when one takes into account the number of advanced cancers, the unnecessary radical operations, and radiations which would be prevented by universal application of this course of procedure.

The recognition of cancer of the cervical canal above the visible portion is a more difficult problem and depends upon the methods to be described under carcinoma of the endometrium. It is usually possible to determine whether the hemorrhage is coming from the cervical canal by plugging the internal os with a cotton-wrapped stick and watching for continued bleeding.

Treatment. In the case of cancer of the cervix it is almost universally conceded that combined radium and roentgenotherapy is at present the method of choice for 2 reasons even in cases in the operable clinical stages: (1) because flat cell cancer is usually radiolabile, and (2) while a few operators have become so adept in radical hysterectomy as to obtain a percentage of cures equal to that of radiation, such a degree of skill can be acquired only through a long period of education during which the postoperative mortality rates are prohibitive. Certainly the occasional pelvic operator should never attempt a radical hysterectomy for cancer of the cervix. In the case of cylindrical cell carcinoma with its theoretically high degree of radioresistance, radical hysterectomy may prove to be the method of choice, if at all possible. If it were feasible to determine in advance whether a given cancer is radiolabile or not, the choice of procedure would be easy.

Unfortunately, radiosensitivity is not accurately indicated by any histological feature, and the failure of test radiation induces changes in the normal tissues which render operation much more difficult and dangerous.

If hysterectomy is attempted too soon after radiation, hemorrhage from dilated minor vessels is apt to prove troublesome or even insuperable, and the impairment of the defense mechanism and of the processes of repair often result in infection and failure in healing. If hysterectomy is delayed too long after radiation, the condensation of the areolar tissue and the obliteration of planes of cleavage make the recognition and isolation of the ureters, bladder, and other important structures very difficult or even impossible.

In the employment of radiation, it is now certain that the combination of radium and adequate roentgenotherapy increases the percentage of cures. There is no generally accepted technique in the use of radium, except as regards proper screening and the essential factor of the single massive dose amounting to 3,600 to 4,800 or more milligram hours. The effectiveness of roentgenotherapy increases with the voltage of the generator and with the proper choice of multiple fields of exposure. Treatment through a single portal with machines of low voltage adds little or nothing to the effectiveness of treatment with radium alone. Roentgenotherapy of cancer of the cervix definitely requires close co-operation between the gynecologist and a radiologist thoroughly trained in the principles governing this particular field.

CARCINOMA OF ENDOMETRIUM

Prophylaxis. Since there are no known fore-running lesions of cancer of the endometrium, the prophylaxis is limited to the application of the principle of immediate biopsy upon the appearance of persistent intermenstrual bleeding, especially in women past the age of 35. As in the case of biopsy of the cervix, the vast majority of cases will prove to be non-malignant. Estrus syndrome, hyperplasia, atrophic endometritis, mucous polyp, submucous or intramural fibromyoma will usually be found yet the adoption of this principle is justified. Biopsy of the endometrium can be done only through curettage, and there are 2 points concerning diagnostic curettage which must be borne in mind: (1) The curettage should include every possible scrap of endometrium, should be saved, and every scrap studied microscopically. The collection should be placed immediately into a basin in which the pathologist tremulously through the masses of clotted blood. (2) The

OBSTETRICS AND GYNECOLOGY

PROPHYLAXIS AND TREATMENT OF CARCINOMA OF THE CERVIX AND BODY OF THE UTERUS

WILLARD R. COOKE, M.D. F.A.C.S. Galveston, Texas

IT is impossible, because of space limitations, to do more than just touch upon some of the essential features of so broad a subject as carcinoma of the cervix and endometrium; moreover there have been no spectacular advances in our general knowledge of cancer during the past year. The fact remains, however, that a great deal of cancer of the cervix can be prevented and a great many cases of established cancer can be cured through the application of our presently imperfect methods of prophylaxis and treatment.

CANCER OF THE CERVIX

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ENDOCRINE THERAPY IN OBSTETRICS AND GYNECOLOGY

JOHN C BURCH, M D , F A C S , Nashville, Tennessee

THE most common endocrine conditions requiring treatment in obstetrics and gynecology are those affecting the process of menstruation. The treatment of these conditions will be discussed in detail, as the underlying principles will be found applicable to other conditions of endocrine origin affecting the female genital tract.

For the rational treatment of any condition an accurate diagnosis is an essential prerequisite, and so it is in the field of menstrual disorders. In a number of previous publications (2, 4, 5) the work of our group has been reviewed, and a detailed exposition of the experimental evidence on which our concept of menstrual disorders is based can be found in these articles (Figs 1 to 4). This general working concept may be stated as follows: Functional menstrual disturbances can result from a lesion in any of the endocrine glands or from some general constitutional condition secondarily affecting the endocrine system. The endometrium indicates roughly the degree of ovarian involvement. There is no constant correlation between the gland affected, the endometrium, or the type of menstrual disturbance.

From this it follows that a primarily diseased ovary may produce endometrial changes and a type of menstrual disturbance identical with those produced by a lesion in some other gland such as the thyroid or pituitary. A menstrual disturbance, therefore, is not a disease, but a symptom, referable to a variety of conditions. To treat all amenorrheas alike is no more rational than to treat all fevers alike. On the other hand, under certain circumstances similar treatment may be applicable to such different symptoms as menorrhagia, amenorrhea, sterility, or threatened abortion.

The general principles underlying the treatment of menstrual disorders have been discussed previously (3, 5). They are (1) an accurate diagnosis, (2) the rational use of endocrine preparations, (3) elimination of contributory disease, and (4) evaluation of rôle of radiation and surgery.

In diagnosing a menstrual disorder, the first essential is to distinguish between the organic and

the functional. In many cases this is easy enough, but in others difficulty is encountered and mistakes are common. Small submucous fibroids are frequently treated for a considerable period by endocrine means. Subserous and intramural fibroids are frequently removed on account of bleeding, only to reveal an abnormal endometrial picture clearly indicating an associated endocrine lesion. The endometrial biopsy and the uterogram will clear up many of these different problems. Carcinoma is, of course, an ever present possibility.

After having determined that the lesion is functional, we must determine the gland primarily affected, as well as any other contributory disease. This calls for a general examination and history, as well as a few simple physical measurements, a basal metabolism, sugar tolerance, and blood chemistry studies. Goldzieher's specific dynamic action test (14), while recently criticized (30), may have considerable value. The evaluation of the data obtained will generally lead to a diagnosis. Hormone assays of the blood and urine are useful in the diagnosis of pregnancy, chorio-epithelioma, and hydatidiform mole. With this exception, hormone assays are valuable chiefly to the research worker and his findings must be carefully and critically analyzed on account of the difficulties inherent in the technique. These methods are not clinical methods and studies of this type can be omitted in clinical work until the methods are further perfected.

In passing it may be said that much of the confusion surrounding endocrinology is due to the fact that research has neglected diagnosis and featured the interglandular relationships. From a practical standpoint, much of this knowledge is useless to the clinician who cannot make a diagnosis.

Endocrine products used in obstetrics and gynecology are the gonadotropes, the sex sterols, and thyroid.

GONADOTROPES

The gonadotropes are of 3 kinds (1) pituitary, (2) chorionic, and (3) equine. The pituitary gonadotropes are derived from the gland itself and consist of 2 fractions: a follicle-stimulating and a luteinizing fraction. Due to the expense of preparing the extracts in sufficient concentrations relatively free from other factors, these extracts

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of a negative biopsy report in a case which is clinically one of carcinoma of the endometrium, the patient should be treated for carcinoma. Of course in most such instances the diagnostic curettage may be omitted.

Diagnostic curettage should be done in every case of premenopausal metrorrhagia. Not infrequently early carcinoma is discovered in the scrapings from a case which is clinically and grossly non-malignant. The possibility of the existence of granulosa-cell tumor of the ovary should be taken into account in every case which is clinically one of carcinoma of the endometrium with a histological report of hyperplasia only since in some cases there is no palpable enlargement of the ovary.

Treatment. The present consensus in cases of carcinoma of the endometrium remains unchanged, i.e. that complete hysterosalpingo-oophorectomy offers the best ultimate percentage of permanent cure and is usually adequate. It is possible that the accumulation of data will indicate that routine postoperative roentgenotherapy may increase the percentage of cures. It is also possible that relatively new methods of combined radium and roentgenotherapy may supplant the operative attack. Since carcinoma of the endometrium usually has a very slow rate of invasion, it is unnecessary in the vast majority of cases to carry out the radical extirpation of the pelvic cellular and lymphatic areas which is required in cases of cancer of the cervix; hence the post-operative mortality rate is quite low. It is, however, important that the cervix and ovaries should be removed in every case, since it is into these structures that extension and invasion are first apt to occur. Routine microscopic study of the material which has been removed, especially the extra uterine tissues, should be carried out and if carcinomatous invasion beyond the myometrium has occurred, the patient should certainly receive intensive roentgenotherapy. Of

course in inoperable cases or those in which extra-uterine invasion is palpable radiation is the only possible method of treatment.

CONCLUSION

While there has been a definite reduction in the incidence and mortality of cancer of the uterus, especially of the cervix, managed throughout by thoroughly competent gynecologists, the general mortality rate from these conditions shows little or no improvement. At present this is due to the failure of the profession at large to recognize and treat the conditions predisposing to cancer of the visible areas of the cervix and to resort to biopsy in all doubtful cases. The greatest hope for reduction of the rates of incidence and mortality of cancer of the uterus lies in the routine examination every 6 months and promptly upon the appearance of any abnormal bleeding or discharge between these periodic examinations of all women over 30 years of age in the recognition and treatment of heteroplasia and leucoplakia, and in the employment of biopsy in all cases of doubtful diagnosis.

In the treatment of actual cancer of the cervix, combined radium and roentgenotherapy is the method of choice. Adequate roentgenotherapy requires (1) complete co-operation between the gynecologist and radiologist, (2) special high voltage equipment, and (3) a technique employing the principle of proper exposures through multiple portals.

Complete hysterosalpingo-oophorectomy remains the generally accepted method of choice in the treatment of carcinoma of the endometrium. Since this condition does not require the very difficult and dangerous extirpation of the pelvic lymphatic areas, the mortality rate is low. It is possible that in the future the development of new principles in the application of radiation to this condition may result in its adoption as the method of choice.

atrophic disturbances of the menopause (18, 28, 41) They are indicated in the treatment of ovarian failure at or near the menopause or following operation On account of their sedative effect upon the nervous system, they have been used extensively in menopausal conditions, although the observations of Pratt and Thomas perhaps indicate that their effect has been overestimated In spite of this I have continued to use these hormones for the treatment of menopausal symptoms and with satisfactory results

In the pituitary cases, dosages of the estrogens range from 1,000 to 10,000 international units per day (in the case of the tablets for oral administration) or from 1 to 3 teaspoonfuls per day of the preparation known as emmenin For the vulvovaginitis of infancy the dosage should be 1,000 international units each day given in the form of a vaginal suppository It is impossible to define the amount necessary to control the symptoms in the menopause, as this will vary according to the amount of estrogen produced by the patient's own ovaries The ordinary range of dosage is from 2,000 to 10,000 international units, this may be repeated daily In the average case, a weekly dosage of 6,000 to 10,000 international units will be found sufficient, although in some instances larger amounts will be needed

While the estrogens have undoubtedly been of great benefit and have contributed much to the happiness of many individuals, certain drawbacks exist as regards their use In the first place, the preparations are expensive and, in the second place, hypodermic administration is often required This has cut down on their practical value These disadvantages have led investigators to seek other substances having an estrogenic effect Dodds in studying compounds with estrogenic activity, was much impressed with the simple substance stilboestrol (derived from stilbene) This substance, while chemically different from the biological estrogens, has all the properties which they possess In addition, it is relatively non-toxic, readily absorbed when given orally, and will be considerably cheaper when commercially available I have been fortunate in having had placed at my disposal¹ a generous supply of this material, which I have used in a series of 16 cases Three of these were patients with severe amenorrhea due to pituitary deficiency in whom a large amount of estrogen had previously failed to produce menstruation One milligram of stilboestrol each day for 25 days produced a normal menstrual flow This preparation

has great promise And from my experience with it, I consider it to be the most valuable addition to our therapy in recent years

Progesterone This term has been agreed upon as the term which is to be used to designate the hormone of the corpus luteum It is now available commercially and has been used in a variety of conditions In my own experience and that of others, it has proved to be of some value in cases of threatened abortion or functional uterine bleeding At the present time, progesterone therapy must be regarded as purely substitutive in nature, although there is some evidence that the corpus luteum hormone may influence the gonadotropic activity of the pituitary (25)

Testosterone (propionate) This male hormone has been the subject of intensive investigation regarding its effect on the pituitary and on the female genital tract It seems fairly well established that short term administration of small doses stimulates the pituitary and that prolonged administration causes a depression of pituitary activity (12, 29) Investigators who have studied its effect in the human female have been impressed by the fact that uterine bleeding can be controlled and checked by the administration of this hormone In a recent study (42), an attempt was made to analyze the effect of this material on the endometrium and it was shown to have a marked effect on the hyperplastic endometrium, consisting in a suppression of proliferation and a lessening of the swelling and edema The typical estrin effect on the endometrium (Fig 5, a) was markedly altered (Fig 5, c and d) and the histological picture was somewhat similar to that seen when testosterone alone was given (Fig 5, e) Gaines, Salmon, and Geist have reported that testosterone exerts an inhibitory effect upon the cyclic changes in the human endometrium

Clinical reports indicate that menstruation can be suppressed entirely by the administration of testosterone and that it will reappear in the course of 2 months' time after treatment is discontinued The hormone has been used in the treatment of dysmenorrhea (23, 35, 37), mastalgia (9, 23), and menopausal symptoms (9, 20) as well as for the control of abnormal uterine bleeding If given in excessive amounts it produces a deepening of the voice and a thickening of the facial hairs These usually disappear after the cessation of treatment Greenhill and Freed recently warned of this occurrence

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have not as yet achieved their theoretical rôle. At the moment, from a practical standpoint, they have a limited value.

The chorionic gonadotropes are derived either from pregnancy urine or human placenta; many reliably standardized and excellent preparations are available. In laboratory animals they produce ovulation and corpus luteum formation just as do the pituitary gonadotropes. They differ from these in that they produce only theca luteinization in the hypophysectomized animal. For this reason they are sometimes referred to as the anterior-pituitary like hormone (A. P. L.). Following the brilliant reports of Campbell and Collip and Novak and Hurd, these extracts have been used with varying degrees of success by many investigators. Some continue to claim exceptional results, while others, notably Hamblen (16), doubt the therapeutic worth of these preparations. In a recent article (16) he has reviewed the evidence and it seems definitely proved that they do not produce ovulation or structural changes in the human ovary or endometrium. Under no circumstances can they be expected to cause ovulation in a non-ovulating woman. In normal women the production of supernumerary corpora has been reported (6, 16, 40). The exertion of an increased amount of pregonadotropin follows their use (1). In my own practice I have found them useful under certain conditions. Their most reliable action is a gonad-maturing one, which is best seen in male cryptorchidism. Their use is indicated in young girls with primary ovarian failure and in these cases they are of great value. In elderly women with primary ovarian failure, they are of less value and may be entirely worthless. They are also useful in secondary ovarian failure for their stimulative action during the time when one is waiting for more specific measures to take effect. On the whole too much has been claimed for these preparations, but when used according to their indications they are extremely useful. As regards dosage, a conservative dose is 500 rat units per day while the patient is bleeding and 250 rat units twice a week during the non-bleeding phase.

Equine gonadotropes are derived from the serum of the pregnant mare. They have been used for some time but, due to patent and licensing difficulties, they have become commercially available in this country only recently. These hormones have been reported by Davis and Koff to produce ovulation in the non-ovulating woman when given intravenously. Hamblen (6) and his group have not been able to secure ovulation by giving them subcutaneously. These preparations

are undoubtedly potent and have much to recommend them. On account of their equine origin the dangers of a reaction must be considered. As sufficient data accumulate, they will undoubtedly find a prominent place in the treatment of various ovarian conditions. Some investigators advocate the use of a combination of the equine and chorionic preparations (22, 24). Rydberg and Östergaard recently reported considerable success in the treatment of amenorrhea by the administration of 2,000 mouse units of an equine gonadotropic preparation (Anter Leo) daily for 5 days followed by 5 injections of 2,000 mouse units each of anterior-pituitary-like hormone every other day.

SEX STEROIDS

Under this term are included a number of different preparations, such as the estrogens, male hormone preparations, and progesterone. The estrogens are undoubtedly the most important of the group and are used by practically all practitioners. The indications for their use are rather well defined and failure to observe these indications has led to much indiscriminate treatment. Their action is three fold. They have (1) a stimulative effect upon the luteinizing hormone of the pituitary (1), (2) a sedative effect upon the nervous system (38) and (3) a trophic effect upon the lower genital tract (33). They are, therefore, indicated in the treatment of pituitary failure both on account of the fact that they stimulate the pituitary and because they make up for the secondary deficiency in estrogen. In pituitary failure it is usually advisable to use them in combination with thyroid on account of the action of this hormone upon the pituitary and also because of the secondary thyroid deficiency which often exists in these cases. This combination of estrogenic and thyroid hormones will be found satisfactory for the treatment of many pituitary cases.

Hamblen (17) has recently reported excellent results from the treatment of menometrorrhagia by the cyclical employment of 10,000 international units of estrogen daily for a period of 21 days followed by 5 milligrams of progesterone daily for 5 days. Most of the patients treated have had regular periods and some, after the cessation of treatment, have continued to menstruate regularly. This form of treatment is rational when applied to the pituitary and ovarian groups. If used in thyroid cases, substitutive therapy with thyroid will be required.

On account of their stimulative effect on the lower genital tract the estrogenic hormones have found a wide field of usefulness in the treatment of vulvovaginitis of infancy (19, 2, 39) and

atrophic disturbances of the menopause (18, 28, 41) They are indicated in the treatment of ovarian failure at or near the menopause or following operation On account of their sedative effect upon the nervous system, they have been used extensively in menopausal conditions, although the observations of Pratt and Thomas perhaps indicate that their effect has been overestimated In spite of this I have continued to use these hormones for the treatment of menopausal symptoms and with satisfactory results

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Fig.

Fig. Human endometrial hyperplasia.

Fig. Photomicrograph of specimen showing endometrial hyperplasia produced in guinea pig by long



Fig.

continued treatment with subcutaneous doses of estrogen.

Fig. 3. Endometrial hyperplasia produced in guinea pig by extreme partial castration.



Fig. 3.



Fig. 4. Endometrial hyperplasia produced in guinea pig by partial hypophysectomy.

logical conditions. Its use is indicated in primary hypothyroidism and in hypothyroidism secondary to pituitary disease. In either instance it is given in doses sufficient to raise the metabolism to normal or until it produces untoward symptoms. While thyroid is one of our most common drugs, there seems to be a general lack of familiarity with the technique of its administration and the results which can be obtained. Many physicians regard it as a rank poison. Nothing could be far

ther from the truth. It is best always to start with a small dose such as $\frac{1}{2}$ grain each day and to continue this dosage for a period of 6 weeks, at which time the metabolism is determined and the dosage increased by $\frac{1}{4}$ to $\frac{1}{2}$ grain. At the end of another 6 weeks the metabolism is again determined and the dosage increased by small amounts only. In case symptoms appear before the metabolism reaches normal, the dosage should be reduced a little for a period of 6 to 8 weeks and then increased again. It is almost impossible to find a patient who will not tolerate thyroid if it is given in this manner. Two points should be especially stressed. In the first place, there is very frequently a paradoxical fall in the basal metabolism in spite of marked clinical improvement. Youmans and Riven consider this a sign confirming the diagnosis and indicating good results. In the second place, in the majority of cases of true primary hypothyroidism, the drug once started, must be continued indefinitely. It is a common experience for patients of this kind, who have been doing well, to have therapy stopped by some other physician on the grounds that they are well. These patients return to their former disagreeable tastes and treatment has to be carried out all over again.

Surgery and radiation still occupy a prominent place in the treatment of menstrual disorders. Curettage is by all odds the best way to stop the bleeding in order to allow specific measures to take effect. In addition, the endometrium thus

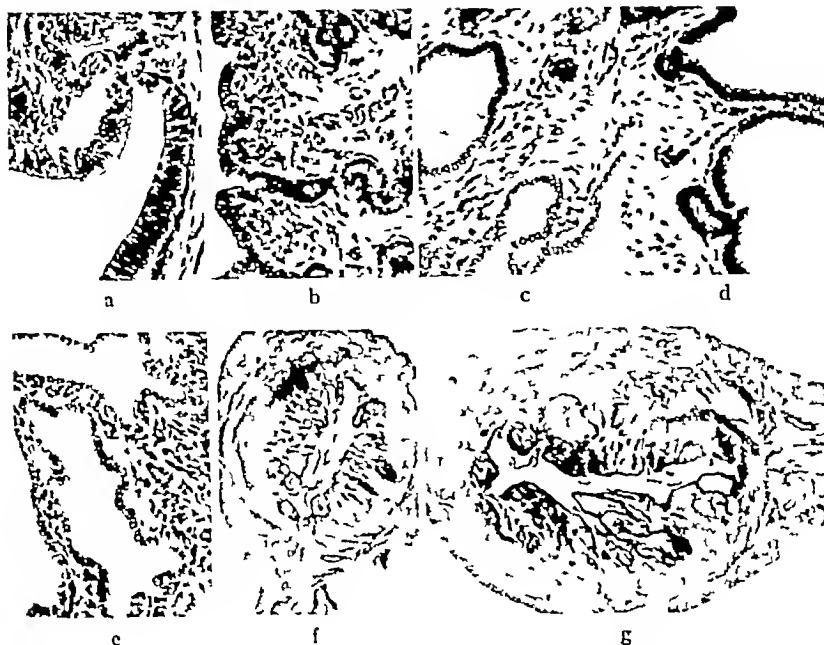


Fig 5 Effect of testosterone on experimentally produced endometrial hyperplasia in the guinea pig a Endometrium of castrate guinea pig which received 65 international units of theelin daily for 55 days b Endometrium of castrate guinea pig which received 65 international units of theelin daily for 40 days, uterus removed 15 days after last injection of theelin c Endometrium of castrate guinea pig which received 65 international units of theelin daily for 40 days, followed by 65 international units of theelin plus 1 milligram of testosterone propionate daily for 15 days d Endometrium of castrate guinea pig which received 65 international units of theelin daily for 40 days followed by 1 milligram of testosterone propionate daily for 15 days e Endometrium of castrate guinea pig which received 1 milligram of testosterone propionate daily for 34 days f Cross section of uterus of castrate guinea pig which received 65 international units of theelin daily for 40 days followed by 65 international units of theelin plus 1 milligram of testosterone propionate daily for 15 days g Cross section of uterus of castrate guinea pig which received 65 international units of theelin daily for 55 days

obtained is valuable in ruling out carcinoma and in determining the degree of ovarian involvement. In certain cases, after consideration of the reproductive function and social and economic factors, as well as the pelvic lesions, hysterectomy associated with endocrine therapy is the most satisfactory means of treatment. I find myself more and more frequently resorting to hysterectomy in those cases in which there are associated pelvic lesions, such as prolapse or cystocele, provided there is no desire for further pregnancies. Vaginal hysterectomy is the procedure of choice under these circumstances.

Radiation can be of 2 types, either stimulative or depressive. Stimulative radiation to the ovaries has produced good results in the hands of Mazer (27) and others, and the dosages recommended apparently can do no harm. The mech-

anism, however, is somewhat open to dispute and much still remains to be learned concerning this form of treatment. Destructive radiation of the types employed near the menopause, of course, will stop the bleeding and will make the ovarian failure complete. In a certain carefully selected group of cases, this is undoubtedly the method of choice, but it should not be used in the younger age groups or in those cases in which the well known contra indications exist.

Fibroid tumors are a frequent reason for pelvic surgery. It has been shown recently by Nelson and previously postulated by Witherspoon that these tumors have an endocrine significance. Not infrequently we remove the tumors and ovaries and stop the bleeding but increase the degree of endocrine imbalance. It is therefore, well to remember that surgery or destructive radiological

procedure does not cure an endocrinopathy but merely removes the symptom and may exaggerate the underlying endocrine process. All of these cases should be studied from the endocrine standpoint and patients treated after operation according to the indications.

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THE MANAGEMENT OF PELVIC DYSTOCIA

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THE management of pelvic dystocia at the Long Island College Hospital has undergone considerable change during the 27 years of my association with that institution. These changes were effected in 3 fairly distinct periods. The first period, 1912 to 1918, was characterized by the relatively large number of destructive operations that were done on neglected patients. The second, 1918 to 1928, covered the time when we were attempting to determine the value of the low cesarean section. It also was influenced by the work of our prenatal clinic. The third period, 1928 to 1939, began the inauguration of our present routine. Since this routine is the outcome of the lessons learned in the first 2 periods, it may be well to review briefly some of our observations made at those times.

At the beginning of the first period, 1912, our prenatal clinic was started, but in spite of the painstaking work of its personnel a large number of our difficult hospital patients failed to avail themselves of its advantages. The ignorant foreign and negro women in our district usually refused our services until their midwives sent them to us after several days of labor had shown that spontaneous delivery was impossible. Our worst cases of pelvic dystocia, accordingly, were admitted many hours after the onset of labor, long after the membranes had ruptured, and after many vaginal examinations had been made. Almost all of these emergency admissions were potentially infected, and in many evidence of intrapartum sepsis was already present. When the child was dead, as it was in most of these cases, delivery was accomplished by means of some destructive operation. Occasionally, however, the child was alive and in good condition. In such circumstances, the patient's religious objection to feticide and our reluctance to destroy a living child compelled us to resort to cesarean section in spite of definite contra-indications to this operation. While some of these destructive procedures were done with comparative ease, others were extremely difficult. In the difficult cases I soon learned that the uterus might be ruptured easily, that the cervix and

vagina might be traumatized extensively, and that many avenues might thus be opened up for the widespread dissemination of any infection that was present. Therefore, if the patient survived the shock and hemorrhage incident to operation, there always remained the chance that she might die from puerperal infection. Even when the operative procedure was an easy one, the patient occasionally died because her condition at the time of admission was too poor to stand any operation.

While the instances in which cesarean sections were done on these neglected patients were not numerous, they were sufficiently frequent to demonstrate the results of suprapubic delivery in such circumstances. Often the patient would recover from the immediate effects of the operation only to die from the abdominal calamity which occurred when the infected uterine wound broke open 5 to 7 days subsequently. Our experience during this first period, accordingly, left us with the following definite impressions: (1) That a destructive operation sometimes requires more skill than is required for the performance of a cesarean section. (2) That a destructive operation cannot always be done in a neglected case of pelvic dystocia without risk to the mother. (3) That cesarean section often can be successfully performed in these cases. (4) That the risk to the mother, however, is too great to warrant the use of cesarean section if she can be delivered by any less dangerous procedure. (5) That the neglected patient's condition may be too poor to stand any operative procedure. (6) That neglected cases of pelvic dystocia are best treated by their prevention through adequate prenatal care.

During the second period, the number of emergency cases was greatly diminished. Due to the growing influence of our prenatal clinic, the majority of our cases of pelvic dystocia then came to us before they went into labor. Antepartum measurement of their pelvis was thus possible and the management of their labors was planned before they entered the hospital. The improvement in our management of pelvic dystocia, which should have resulted from this good work of our prenatal clinic, however, was vitiated to some extent by our unfortunate experience with the low cesarean section. The results of this operation in potentially infected cases were so good that we

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were misled into believing this procedure to be safer than it really is. A fairly large series of cases was accumulated in which the operation was done late in labor, long after the membranes had ruptured, and after vaginal examinations and manipulations had been made. In these cases, the results were so good that we felt justified in giving all of our borderline cases of contracted pelvis a full test of labor. By this I mean that the labor was allowed to continue until the cervix became fully dilated and the patient had shown by several hours of good second stage pains that the head could or could not pass through the pelvis. If after such a test the head failed to enter the pelvis, a low cesarean section was done. After a considerable experience, we learned that our early results were too good to be true and we were compelled to concede that even the low technique did not protect the patient against the hazards which accompany cesarean section performed long after the time for its safe performance has passed. Thus it may be seen that instead of operating upon neglected emergency patients, as we did in the first period, we neglected our own patients and then operated upon them. This mistake in our former routine is frankly acknowledged and it is hoped that others may profit by its publication.

While our pioneer work with the low cesarean section revealed the limitations of the operation, it also demonstrated the value of this technique. Although the operation cannot be done without a 3 to 5 per cent risk after the patient has been in labor 14 hours, or after the membranes have been ruptured many hours or after a number of vaginal examinations have been made, we believe that it can be performed with relative safety after the patient has had 10 to 15 hours of labor even though the membranes have been ruptured for several hours, provided no vaginal examination has been made and the labor has been conducted with care. Our observation of these patients during a real test of labor also taught us that it is possible in the majority of borderline cases to tell whether or not the head will enter the pelvis long before a full test of labor has been completed. From the experience gained during this second period, we accordingly learned that (1) even the low cesarean section is not safe when it is done too late in labor long after the membranes have been ruptured and vaginal manipulations have been made. (2) The low cesarean section can be done after 10 to 15 hours of labor even when membranes have been ruptured several hours if no vaginal examinations are made and a good technique is followed throughout trial period. (3) That a full test of labor is not necessary in the majority of borderline pelvic contractions.

After having thus learned the limitations of the low cesarean section, the risk in pelvic dystocia was considerably diminished in the third period by eliminating the complete test of labor in the majority of cases in which it formerly was used, and by substituting for it a trial labor which was not to exceed 15 hours whenever cesarean section was contemplated. Since this change marked the inauguration of our present routine, I shall now discuss our present teaching concerning the management of pelvic dystocia.

Diagnosis. Until recently the diagnosis was made by means of external and internal pelvimetry exclusively and this means of ascertaining the size of the pelvis is still the only method available to most practitioners. The ordinary external measurements, because of their marked variations in women with normal pelvis, are of little or no value, unless they are markedly contracted, except as a means of differentiating between the different types of contraction. More important are the diagonal conjugate which extends from the inferior margin of the symphysis to the promontory of the sacrum, and the biischial diameter which lies between the ischial tuberosities. If the diagonal conjugate measures 13 centimeters or over the inlet of the pelvis in all probability is ample and engagement of the head may be anticipated unless the child is larger than normal. Likewise the outlet is usually sufficiently large whenever the biischial diameter exceeds 8 centimeters. Unfortunately much experience is necessary before these measurements can be made with any degree of accuracy. For this reason, many errors are made in ordinary practice and cases of pelvic dystocia are not recognized until the patient has shown by a prolonged labor that the head cannot pass through the pelvis. This unfortunate circumstance might be avoided if the average practitioner would have competent obstetric consultation to rule out the possibility of cephalopelvic disproportion whenever the head in a primigravida is not fixed in the pelvic inlet at the onset of labor or whenever the abdomen is pendulous or overriding is present in any primiparous labor. If facilities for satisfactory pelvic roentgenograms are available the pelvis may be measured according to the method of Thomas or that of Caldwell and Moloy. The results of these roentgenographic studies are so promising that an extension of their use to every sizable community in the country may be predicted. When this occurs, it is to be hoped that every woman will have the size of her pelvis determined by means of roentgenography before she is married or when she becomes pregnant just as she is having

a premarital or a prenatal Wassermann test done at the present time in some states. When this is done, all cases of contracted pelvis will have sufficient warning of possible dystocia to lead them to seek the services of a well trained obstetrician for their confinement.

Delivery Whenever the anteroposterior diameter of the inlet as determined by means of the diagonal conjugate or by means of roentgenography is 8 centimeters or under, the child is delivered by cesarean section before or at the onset of labor, unless the labor is premature and examination shows the head to be small. While it is possible that a living child may be born through a pelvis with a true conjugate of 8 centimeters, the chance of its not going through is so great and the risk of elective cesarean section is so slight that we are justified in resorting to suprapubic delivery at the time when this operation can be performed with the greatest safety.

Unfortunately, most of our cases of contracted pelvis have a true conjugate between 8 and 10 centimeters in length. In these the possibility of delivery through the natural passages is always present and becomes greater with each half centimeter increase in the anteroposterior diameter of the pelvic inlet. Because much depends upon the character of the uterine contractions and the malleability of the head, it is our custom to allow women with such borderline pelvis to go into labor. Soon after the onset of good contractions an attempt is made to force the head into the pelvis and the cephalopelvic relationship is determined by a modification of the method of Mueller. An assistant makes pressure over the fundus of the uterus and in the axis of the pelvic inlet while the examiner grasps the sides of the head with one hand and attempts to force it into the pelvis. At the same time, he notes by rectal palpation the effect of this maneuver on the descent of the head. If the presenting part can be forced to within a centimeter of the level of the ischial spines, delivery through the pelvis is awaited. If, on the other hand, the head cannot be forced into the pelvis and a considerable portion of it overrides the symphysis pubis, the child is delivered by a low cesarean section. When the head cannot be forced into the pelvis and little or no overriding is present, labor is allowed to continue in the hope that sufficient molding may occur to permit engagement. Several hours later, this maneuver is repeated and the relationship of the head to the pelvis is again determined. If at that time, no progress has been made, and the true conjugate is less than 9 centimeters, suprapubic delivery is decided upon. When the measurement is 0 centi-

meters or over, the trial labor is continued even though no progress has been made. From this it may be seen that cesarean section is favored whenever there is no progress and the measurement is only slightly above the upper limit for an elective operation, while delivery through the passages is anticipated in all other borderline cases. This trial labor, however, is terminated within 15 hours after the onset of labor and within 4 hours after the membranes have ruptured in all cases in which cesarean sections are contemplated. In other words, the decision either for or against cesarean section must be made at some time within these limits. Stereoscopic roentgenographic observations during the course of a trial labor are of value. As the use of this method is extended and our experience grows, these accurate roentgenographic studies should assist greatly in the management of difficult borderline cases.

In outlet contractions, the posterior sagittal diameter is measured. Whenever the sum of this measurement and the buschial diameter is under 15 centimeters, elective cesarean section is done. Here again, the more accurate roentgenographic techniques offer considerable help in that they correctly show the length of the symphysis, the acuteness of the subpubic angle, and the size and shape of the sacrosciatic notch. Their use, accordingly, may prevent some of the cases of "failed forceps" which occasionally result from too great a narrowing of the posterior region of the pelvis.

When the routine outlined is followed in the management of labor in contracted pelvis, most women are delivered through the natural passages. Labor is conducted in the usual manner with the exception that vaginal examination is avoided and rectal examinations are restricted whenever the possibility of cesarean section is considered.

Forceps may be required as they may be required in any labor and the indications for their use do not differ from the ordinary indications. They are never applied until after engagement has taken place. If it is good practice to refrain from the use of forceps before the head is engaged in cases without cephalopelvic disproportion, it cannot be good practice to apply them when the pelvis is contracted and failure of engagement following a test of labor demonstrates the need for either reducing the size of the head or delivering from above. Forceful efforts to drag a head through a pelvis that is too small cause irreparable damage to the mother and result in the death of the child. High forceps, accordingly, have no place in the treatment of pelvic dystocia.

The fact that the head in breech presentation enters the pelvis with relatively smaller diameters than in vertex cases formerly led some obstetricians to recommend podalic version in the treatment of contracted pelvis. While the after-coming head may be regarded as more wedge-shaped and in rapid extractions should enter the pelvis more readily it does not have an opportunity to become molded and accordingly is much less advantageous than an occurring head. The old recommendation that version be done for moderate degrees of pelvic deformity therefore, is not advised and version is limited to those emergencies which require rapid delivery before the head is engaged but in which the head is thought to be sufficiently small to enable it to pass through the pelvis. For similar reasons, the problem in contracted pelvis is more difficult when the breech presents. In these circumstances, the cephalopelvic relationship cannot be ascertained until the aftercoming head reaches the pelvic brim. When marked disproportion is not recognized until this stage of labor is reached, it is too late to consider suprapubic delivery and the child is invariably lost. This inability to study the fit of the head into the pelvis when the breech presents should lead to more frequent resort to cesarean section than has been recommended in the routine suggested for vertex cases.

Induction of premature labor unquestionably assures a larger number of intrapelvic deliveries than the plan outlined but it is accompanied by a high fetal mortality. In many instances, the child is smaller than anticipated and the problem of bringing up a small premature infant is encountered. Since the risk to the mother and child is so slight when the routine described is followed, we believe it to be preferable to one in which a large proportion of the infants are lost. The induction of premature labor accordingly, has not been considered in our management of pelvic dystocia.

SUMMARY

1. The possibility of pelvic dystocia should be recognized by measurement of the pelvis during the prenatal period.
2. External measurements are of little value in

determining whether a pelvis is or is not contracted.

3. The diagnosis depends upon the length of the diagonal conjugate and the biischial diameters, or upon the measurements obtained by one of the accurate roentgenographic techniques.

4. It is to be hoped that every woman will have the size of her pelvis determined by means of roentgenography before she is married or when she becomes pregnant just as she is having a premarital or prenatal Wassermann test done at the present time.

5. Elective cesarean section is advised when the true conjugate diameter is 8 centimeters or under.

6. Borderline cases of pelvic contraction are given a trial labor and the decision either for or against cesarean section must be made within 15 hours after the onset of labor and within 4 hours after the membranes have ruptured.

7. The use of stereoscopic roentgenographic studies in the course of the trial labor is advised.

8. A full test of labor is not necessary in the majority of borderline pelvic contractions.

9. The low cesarean section is not safe when it is done too late in labor long after the membranes have been ruptured, and after vaginal manipulations have been made.

10. It is a relatively safe procedure when it is done within 10 to 15 hours after the onset of labor and within 4 hours after the membranes have ruptured, provided no vaginal examinations have been made and a good technique has been followed throughout the trial labor period.

11. A destructive operation sometimes requires more skill than is required for the performance of a cesarean section.

12. A destructive operation cannot always be done in a neglected case of pelvic dystocia with out risk to the mother.

13. Even in neglected cases, cesarean section often can be performed successfully but the risk to the mother is too great to warrant its use in such circumstances if she can be delivered by any less dangerous procedure.

14. High forceps, podalic version and the induction of labor are not recommended in the management of contracted pelvis.

TOXEMIAS OF PREGNANCY

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THERE are only 2 toxic states due to pregnancy hyperemesis gravidarum and eclampsia. The only factor in common is that both are ovarian in origin—that is, both have their inception in placental tissue, but because of the time of inception in the short life span of chorionic tissue, the substances formed and the symptoms resulting are as different as those from ingestion of unripe and overripe apples.

While placental tissue remains such from the first thread like villus to senescence, it undergoes remarkable changes in the rate of cell proliferation, function, and appearance. An animated picture of the first 10 weeks of placental development would display action above all else. It rapidly attains a high weight ratio of ovarian tissue to embryo. This ratio is reversed later but in a more gradual manner. There is marked proliferation of chorionic epithelium, rapid development of ferment bearing cells, and arrangement of the syncytial cells over the layer of Langhans. There is also complex structural arrangement of the villi permitting osmosis with the maternal circulation. Real early the placenta, in addition, takes on with the pituitary the function of the formation of a gonadotropic hormone. It is during this embryonal period of the placenta that hyperemesis develops. It is during advanced age and senescence of placenta that eclamptic toxemia develops.

For a number of years it has seemed to the writer that the most tenable thesis as to the etiology of hyperemesis is that during this period of rapid development of the placenta, a specific protein substance, of which the syncytial cells may be the chief component, is thrown into the maternal circulation. This protein substance, which is exogenous, could produce the symptoms, the ovum is parasitic. This protein substance might act by reason of its molecular structure, its lytic action, or by possessing agglutins, as it might in cases of incompatible blood groups in parents.

If the foregoing could be the basis for moderately severe nausea and vomiting, one might postulate that in an allergic individual, the extreme sensitivity to foreign proteins, combined with dehydration, starvation, and vitamin deficiency, could produce the pathology found at

autopsy in death from hyperemesis gravidarum. If the obstetrician will question patients with hyperemesis, he will be surprised to find out how frequently he can elicit a history of allergy in the patient or her antecedents. Several years ago the writer made an attempt to desensitize these patients by injecting blood serum from the husband. The results were not satisfactory enough to warrant the continued annoyance to the husband or the loss of time spent in procuring, keeping, and giving the serum. Later a sterile milk preparation was used with about the same result. Since then much progress has been made by the allergist in the method of desensitization. It may be that their services can now be enlisted so that this method of treatment can be given a fair trial.

The psychogenic factor in hyperemesis must always be taken into consideration, but the assumption that it is the sole cause is as unscientific as it is unfair and unsympathetic. It can be seen readily that economic stress or failure of social or marital adjustment might be the conscious or subconscious motive for not desiring the pregnancy. It is an interesting fact that many of my patients with hyperemesis have been unusually bright women with slight paranoid personalities. In other words, it is the potential career woman who probably subconsciously rebels at the self-negation of marriage, and the prospect of complete nihilism with reproduction. I am unwilling to admit that even in these cases the psychogenic factor was the sole cause. To conclude that the vomiting which was carried on to dehydration, starvation, and death was produced solely by a psychogenic factor, would require that the autopsy of this patient be the same as the autopsy findings in cases of starvation.

ECLAMPTIC TOXEMIA

We believe that pre-eclampsia, as characterized by hypertension, is caused by proteinogenous amines, especially tyramine, and that eclampsia, characterized by hypertension plus capillary spasm, is an allergic reaction to the same amines.

Young, in 1914, was the second worker to point out the significance of placental infarction with reference to toxemia. Young contended that cell autolysis in the infarcted area eventuated in split proteins which caused the symptoms. In 1927, 1928, and 1929, Dr. H. O. Nicholas, head of

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Department of Biochemistry Rice Institute Dr Robert A. Johnston, my associate, and the writer (20 21 22) started in where Young left off with his split proteins, and began biochemical analyses of the blood, urine, vomitus and placentas from eclamptic patients. We took advantage of the exhaustive work of Hanke and Koesler (1 19) on proteinogenous amines, which was done at the University of Chicago from 1921 to 1926. This work will be referred to later. Specimens were first examined for histamine, the ideal endothelial toxin, but Dr Nicholas was never able to get a positive reaction. Tyramine was next, and the first reaction was obtained from material gathered by gastric lavage. This had been done at the suggestion of Dr Caldwell, who stated that whatever the toxin was, the gastric mucosa was instrumental in its elimination. This was followed later by positive tyramine reactions for this eclamptic's blood, placenta, and urine. In 1936, Muller and Govaerts found tyramine in the blood serum and cerebrospinal fluid of eclamptic patients. Also in the same year Leeper and Lesare found tyramine in the blood serum in cases of hypertension. For our purposes we appropriated that part of the work of Hanke and Koesler on proteinogenous amines which showed that there are strains of pathogenic bacteria which in culture media, converted histidine into histamine, and tyrosine into tyramine. This conversion was due to enzymic action. Pure strains were specific in action that is, an organism capable of producing tyramine could not produce histamine and vice versa. Over 80 organisms were found to possess this quality notably various strains of *Bacillus coli* and *Streptococcus hemolyticus*.

Any theory as to the etiology of eclampsia must explain the commonly observed facts, namely it occurs only in the human female; a placenta must be present, or a symptom continuity with a placenta; the condition is more common in primiparas, twins, overweight babies, and polyhydramnios. Its incidence increases during or following respiratory epidemics and it follows severe *Bacillus coli* infections too frequently to be accidental.

It is our theory that the upright position, which is maintained only by the human female, often causes venous back pressure, as shown by varicose veins, hemorrhoids, varicosities of vulva, vagina, and broad ligaments. This venous back pressure of the upright position is a factor under certain conditions of pressure in causing alterations in the uteroplacental circulation, that is, stasis in the intervillous spaces. These conditions are, first pregnancies, late pregnancies, large babies, and polyhydramnios. When these areas of

stasis develop and are maintained for some time, the chorionic cells are deprived of nourishment and die. Cell autolysis then follows. The chorionic tissue is reduced to its amino-acid content, just as liver tissue is reduced in acute yellow atrophy with the production of amino-acids. Let me say here for the purpose of clarifying our so called "circulatory insults," of which infarction is often the visible result, that we do not give infarction the importance which we formerly did. Dr Nicholas found that tyrosine accounted for 4.26 per cent of the dried weight of placental tissue. Hence, a few scattered areas of stasis with cell autolysis would produce adequate tyrosine. If this intervillous stasis with its consequent destruction of chorionic tissue is extensive, hemorrhage takes place in this area. This hemorrhage is probably a protective mechanism by the fetus for the destruction and removal of destroyed tissue from channels of absorption. However such parts of the affected area contiguous to the intervillous spaces may have been the source of the tyramine which produced the symptoms. In other words, eclampsia does not require visible infarction. A placenta without visible infarction from an eclamptic toxemia will show tyramine. Therefore, it can be inferred that the different areas of stasis were the source of the tyramine.

Reverting to the area of chorionic cell autolysis with its reduction to amino-acids, it must be admitted that even if the absorption of these amino-acids were rapid their effect would hardly be toxic. The circulation, unless the liver is completely destroyed, can take care of these without difficulty. They must be converted into their respective amines in order to become toxic.

Source of the toxin. The ability of bacterial enzymes to convert amino-acids to poisonous amines gives a possibility of conversion in the placenta under conditions previously outlined. We are anxious for this to be so, because with the placenta as the source of the toxin, which we firmly believe, it is easier to explain certain frequently observed and well known facts. Naturally one would think the source of the tyramine found in the blood stream and the placenta to be from the intestinal tract, especially the colon. But on investigation it is found that though tyramine is formed in the large intestine due to its affinity and attachment for small particles contained within the lumen of the bowel practically no tyramine or histamine passes through the mucosa into the portal vein. *In extremis* it does, but the onset of pre-eclampsia is not *in extremis* in the patient. If small quantities of tyramine do get into the portal vein and to the liver it is

quickly de-aminized by a tyramine oxidase. With these difficulties to surmount, especially with a well patient, it is not easy to prove that the tyramine in the blood had its source in the large intestine.

Reverting to the placenta as the source of the toxin, the following facts are significant. A human female, and a living placenta, or a symptom continuity with a placenta is absolutely essential to eclampsia. If and when the toxin is formed in the manner heretofore outlined, its permeability and absorption depend on the normal, uniform pressure between the area of formation and the intervillous spaces. That absorption does not take place otherwise is shown by the improvement following death *in utero*, with rapid absorption of the amniotic fluid. Rupturing the membranes is followed by improvement. Here again with the lowering of the intra-uterine pressure, but with the placental circulation still functioning, there is not such a disturbance in the uniform pressure. There is further proof that the placenta is the source of the toxin. Improvement rapidly follows the birth of the placenta. While toxemia generally affects the baby to a less extent than the mother, we reported a case of eclampsia in a newborn in which hypertension in the mother had escaped detection.

Tyramine is a toxic amine with a pressor action. It is somewhere between histamine, the universal irritant, and guanidine which, no doubt, is much milder in action. Chemically, it is quite similar to the physiological amines, adrenalin, pitressin, and pitocin, and also similar in action to the amino acid thyroxin. The hypertension from tyramine is primarily the result of direct irritation to the vasoconstrictor terminals of the capillaries, and secondarily to irritation of the glomeruli of the kidney. It is possible that after de-aminization of the tyramine, the irritation to the glomeruli continues the hypertension until this irritation has subsided. This accounts for the hypertension prior to the appearance of albumin and the continued hypertension longer than the pharmacological action of tyramine would produce.

In former papers we have reported experiments of injecting into the peritoneal cavity of dogs extracts of sterile placental tissue and of incubated non-sterile placental tissue. We have also reported the production of peripheral necrosis in dogs by injecting large doses of tyramine into the portal circulation. We have reported the time required for the de-aminization of tyramine in the circulation of dogs and also in the human. We have reported the production of the characteristic occipital and frontal headache of pre-eclamptic toxemia in the human. We have also reported the

tyrosine content of dried placental tissue, and have shown that the amount of tyrosine in approximately a dram's weight of dried tissue would be lethal if rapidly converted and absorbed. Our last paper (25) gave the following conclusions:

- 1 With our present methods of blood protein precipitation and analysis we cannot at this time describe any blood chemistry picture peculiar to eclampsia, involving variations in non-protein nitrogen, urea, uric acid, amino-acids, or creatine.

- 2 There does not seem to be any increase in the undetermined nitrogen fraction of the non-protein nitrogen content which might indicate the presence of large amounts of toxic amines.

- 3 Tyramine seems to be the only amine definitely associated with the clinical symptoms of eclampsia. Also, the amount of tyramine does not seem to be directly connected with the severity of the clinical symptoms.

The last part of paragraph 3 of our conclusions was best explained by inferring that the difference between the quantity of tyramine in the blood and the symptoms exhibited by the patient was due to allergy. No facts had been gathered to support this inference. During the past year a weak attempt has been made by the writer to assemble such information as would throw light on the question. A brief statistical study of late toxemia shows that approximately 10 per cent of pregnancies at or near term exhibit various degrees of hypertension, 2 per cent develop moderately severe toxemia, and eight tenths of 1 per cent exhibit hypertension plus capillary spasm. For purposes of this paper evidence of capillary spasm is limited to angiospasm of the retinal arterioles and convulsions. The visual disturbance of retinal angiospasm is well known. It is an assumption that convulsions are due to a sensitive cortex with angiospasm and edema. If some cases of excruciating headache, abruptio placentæ, generalized edema, and marked albuminuria were added, this group would be over 1 per cent.

An investigation to support the allergy theory would include: First, history of allergy in patient or antecedents, second, evidence that the substance investigated ever produces allergic reaction, third, skin testing. In order to elicit a history of allergy, a voluminous questionnaire must be prepared and interpreted by an allergist. Information from this source was abandoned. It is interesting, however, to note that casual questioning of a toxemic patient will bring forth from the patient or mother some first-hand information about "uremic poisoning." There is some evidence that we have eclamptic families as well as asthmatic families. The writer knows a family in

which 3 of 4 daughters had convulsions with the first pregnancy. Chen, whose pharmacological studies were conducted on dogs, gave a man some tyramine acid phosphate by mouth. This was followed later by an extensive urticarial rash. We are all familiar with the urticaria which occasionally appears in a patient convalescing from eclampsia. The same character of rash is often noted in babies born of eclamptic mothers.

The skin testing was done after invoking the aid of an outstanding allergist. It wasn't long before the writer could see that he was being taken into unknown fields, fields of anaphylaxis, atopic reactions, transferred sensitivity, etc., etc. To the writer the question seemed more simple. Does a given solution of tyramine with a known hydrogen ion content, when given intradermally to different people produce a reaction with slight individual differences, or a reaction with marked differences? Naturally, the identical solution must be given to the individuals, the amounts given must be the same, and the gauge of needle the same. Methods of the allergist can be used then in interpreting the reaction—size of wheal, pseudopods, extent of erythema, or flare, and duration of reaction. This, then, may be indicated from + plus to 4 plus. Normal saline was used for control. The solutions of tyramine hydrochloride, were marked 1 3 4, and arranged from .003 to .00003. The quantity given was two one hundredths of a cubic centimeter, the gauge of needle was 27.

Twenty patients have been tested. In the majority of cases, patients were selected who had had or were suffering from hypertension plus capillary spasm, and also patients with marked hypertension alone. The number of cases has been small and this is only a preliminary report. No claims whatever are made, but the tests seem to indicate that those who have hypertension with capillary spasm show marked sensitivity to very weak dilutions of tyramine.

SUMMARY

The suggestion is made that the specialty of allergy may be instrumental in solving the etiology of hyperemesis gravidarum.

The theory regarding eclamptic toxemia which we have tried to support requires that () exists in the intervillous spaces must be of sufficient duration to cause degeneration of chorionic tissue, with the production of tyrosine (2) that only through infective processes with bacteria or enzymes circulating in the blood is the conversion of tyrosine to tyramine possible (3) the absorption of the tyramine formed depends on the condition

of uniform pressure as outlined in the paper (4) tyramine circulating in the blood in pregnancy produces only hypertension and (5) in the sensitive or allergic patient, tyramine produces by pertension plus capillary spasm which is the pathological unit of eclampsia.

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SYMPOSIUM: OTORHINOLARYNGOLOGY

LARYNGECTOMY A PLEA FOR A NARROW FIELD OPERATION

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HISTORICAL matters would be out of place in this paper. Moreover they have been extensively reviewed in a recent publication in which I collaborated (11). A few historical phases must be mentioned here because their persistent remnants seem to frustrate efforts at certain improvements in technique. A few of the historical errors of which we inherit remnants are the following:

- 1 Laryngectomy during the first 27 years of its recognition as a practicable operation was done only in advanced cases of malignant disease of the larynx. In not one case does the history show that there was an early diagnosis.

- 2 In all cases the growth was extrinsic by origin or extension.

- 3 Biopsy was not done.

- 4 Direct laryngoscopy was ignored.

- 5 Great store was set by the presence of hard lymph nodes as a diagnostic feature and laryngectomy was seldom done in their absence.

- 6 Surgeons were misled by applying to the larynx the principles developed in the operations for cancer of the mamma and axilla, regions quite different anatomically and pathologically from the larynx. In operable cases of cancer of the larynx we are dealing with squamous cell carcinoma and it is inside a cartilaginous box with 2 layers of perichondrium, which constitute 3 barriers that do not exist in the mamma. If we do a laryngectomy at the early period at which it should be done, we take out that box and its contents before leakage has occurred.

- 7 Practically all laryngectomic techniques were based upon search for and removal of cervical lymphatics whether involved or not.

WIDE FIELD LARYNGECTOMY

Under conditions enumerated in the foregoing paragraphs only a wide field operation could afford the ample access necessary. Unquestionably

the wide field is easiest for the operator. To lay back huge flaps, open up the whole front of the neck, layer by layer, cut away the muscles, identify the anatomical structures serially as in the dissecting room constitute the comfortable way to work. So also would be a lengthy incision for laparotomy.

The disadvantages of a wide field laryngectomy are so many and so vital that it seems proper to raise the question whether or not a wide field is necessary in all cases. These disadvantages are (1) shock, (2) trauma, (3) impaired blood supply, (4) flaps, (5) air-pocketing, (6) large wound, (7) increased flow of serum, (8) retarded healing, and (9) greater risk of pharyngostoma.

Shock. There seems no reason to question the greater degree of shock in the wide field operation. It seems equally evident that to some degree shock retards healing processes. Otherwise the importance varies with the equation of the particular case.

Trauma. By all the techniques of wide field operation the amount of trauma is necessarily much greater than in a carefully executed narrow field operation. The greater the trauma the greater the time for healing, and traumatized tissues favor sepsis.

Impaired blood supply. Unquestionably a larger wound means more vessels cut, and more hemostasis means prolongation of operative time. But these are of less importance than the fundamental fact that the wide field operation invades a region of greater vascularity extensively as compared to the small anastomotic arterial twigs found in the median line (Figs 1, 2). Impaired blood supply means retarded healing. Retarded healing invites sepsis in a region where a septic field like the pharynx is concerned in the operation. In such a wound, if healing must await re-establishment of an extensively interrupted blood supply, trouble is almost certain.

Flaps. In a wound exposed to infective risks, such as pertain to laryngectomy, flaps are objectionable inversely as their blood supply. Anemic

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flaps do not become necrotic often but they inevitably retard healing and thus invite infection. To lay back huge flaps gives the surgeon easy and comfortable access to all the anatomical structures in the neck, but the ease and comfort are too often offset by the consequent postoperative anxieties.

Air pocketing. A wide field, with large flaps and extensive muscular excisions, multiplies the difficulties of eliminating air and serum pockets, and if these are not eliminated they will retard healing and increase infective risks. The stump of an expected muscle makes a pocket difficult to obliterate.

A large wound. It is true that under aseptic and otherwise favorable conditions a large wound heals as quickly as a small one, yet under conditions present in laryngectomy a large wound, with its lesser support of the pharyngeal repair, greater flow of serum and increased tendency to air pocketing multiplies the risks of infection. When infection does occur the breaking down of the large wound means extensive suppuration, sloughing and a large area for septic absorption.

Retarded healing. Of course primary union is always desirable and sometimes obtainable after laryngectomy but what is even more important is that anything that retards healing enormously increases the infective risks. A healthy wound with little trauma and little interference with blood supply has the best chance of prompt healing and the highest resistance to infection. On the contrary a sloughy wound with large anemic flaps favors the breaking down of the pharyngeal repair.

Pharyngostoma. All of the factors referred to in the foregoing paragraphs add up to a high percentage of pharyngostoma, and especially to large pharyngostoma, which is the most troublesome of all laryngectomic sequelae.

To the enumeration of all of these disadvantages the objection will be raised that they are unimportant compared to the 100 per cent mortality of untreated cancer of the larynx. This is true, but it does not imply that we should not seek less risky and equally efficient means of dealing with this dire disease.

All that has been said here may be misconstrued as condemnation of a wide field laryngectomy calling for constructive suggestions. With no expectation of general acceptance I venture to make the following suggestions.

A narrow field laryngectomy should be done in suitable cases. That is to say the larynx should be removed through a midline incision without flaps.

2. No search ought to be made for metastatic lymphatics when no nodes are palpable. If evidence of lymphatic involvement should develop after a narrow field operation, excision can be done as a relatively minor operation free of septic risks, the lymph channels can be sealed up by irradiation or both of these measures may be combined. Probably large scale a crico would be as good as from the wide field operation. My opinion is that all metastatic material cannot be removed from the neck by any operative procedure no matter how radical.

3. When lymph nodes are palpable the case is one for irradiation rather than laryngectomy. My experience in this respect supports the opinion of Crowe and Broyles and a few other laryngologists.

4. A good way to eliminate wide field laryngectomy is to make an earlier diagnosis of cancer of the larynx. A still better way would be to make a diagnosis so early that the cancer would be amenable to treatment by laryngofissure; then the patient would not lose his larynx by either wide field or narrow field laryngectomy. If hoarseness in an adult were considered as probably cancerous and calling urgently for immediate diagnosis, laryngectomy would rarely be necessary. Delay in diagnosis of cancer of the larynx is inexcusable. It can be made early and promptly by biopsy.

To prevent misunderstanding it should be emphatically stated that the narrow field operation is advocated only for early intrinsic disease that is too extensive for the laryngofissure route. It would be a deplorable mistake then to operate in a case of cancer that is extrinsic by origin or extension or on a patient with palpable lymphatic involvement. If the surgeon believes in operative treatment of such cases, a wide field operation is necessary.

NARROW FIELD LARYNGECTOMY

By the term narrow field laryngectomy I mean an operation in which the larynx, and the larynx only is removed through a midline incision. Its greatest advantage is that in most cases it is followed by such rapid healing that the risks of infection, sepsis, sloughing, breaking down of pharyngeal repair and pharyngostoma are avoided.

Indications. Narrow field laryngectomy is indicated in cases of malignant disease of the larynx in which the lesion is still intrinsic and of limited extent, though too far advanced to warrant laryngofissure.

Contra-indications. A narrow field laryngectomy is not to be considered under the following conditions: (1) a lesion extrinsic by origin or

extension, (2) involvement of the internal perichondrium, even though it be only inflammatory, (3) impairment of arytenoid mobility, (4) any evidence of lymphatic involvement even if only inflammatory. Very careful delicate and deep palpation is necessary to discover lymphatic involvement in some cases. (5) A high degree of malignancy as indicated histologically, (6) general contra indications to any operative procedure. Though these cannot be ignored they are less important than in a wide field operation because shock is much less. My opinion is that laryngectomy is contra-indicated in a patient who, apart from cancer, would be rated as having less than average life expectancy, as judged by actuarial standards.

Technique of narrow field laryngectomy In presenting the following statement of a few of the basic technical features of the narrow field operation it should be emphasized that they are not intended to apply to a wide field laryngectomy. It is hoped this will be borne in mind in discussion.

1 One absolute essential is good illumination, it must be equal to and not unlike that required for intranasal surgery. The ideal is a beam projected into the wound nearly parallel to the operator's visual axis.

2 In the choice of an anesthesia, the operator is free to follow his preference except for the following restrictions. Infiltration is objectionable because of local trauma if perfect analgesia is obtained. Inhaled ether is objectionable because of bronchial hypersecretion. Profound, prolonged anesthesia of any kind is objectionable. The shorter the time the cough reflex is abolished the better. If morphine is used at all, it must be in one small dose before operation and not repeated, so as not to interfere with prompt restoration of the laryngeal reflex. Atropine should not be used.

These restrictions narrow the choice to chloroform (5, 22), nerve block (18, 19), and the group of drugs represented by avertin (1, 17). Light chloroform inhalation has many advantages, but it must be administered by an anesthetist not only experienced but enthusiastic in its use.

3 A median line incision that goes through only anastomotic arterial twigs is made (Figs. 1 and 2). It should extend from the hyoid bone to the suprasternal notch. If emergency or anatomical anomaly should require it the incision can be extended upward by median division of the hyoid bone, as in the New operation. No transverse incisions are made.

4 No flaps are dissected up; the integument is left normally attached to deeper structures. The subcutaneous is deepened by clean cutting until

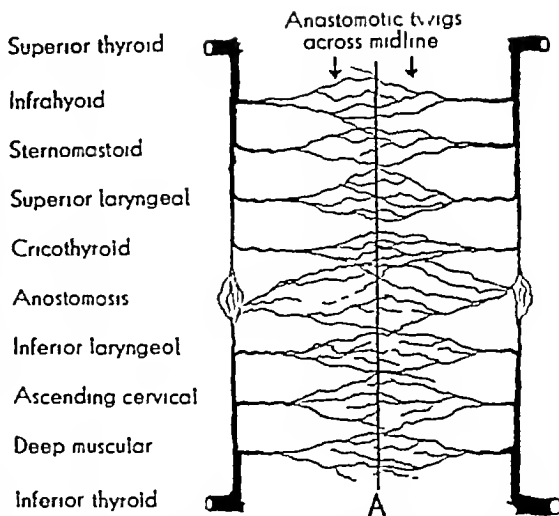


Fig. 1 Diagram of the arterial supply of the tissues concerned in laryngectomy. The supply comes from lateral trunks, chiefly the superior and inferior thyroid arteries. The upper and lower trunks anastomose freely with each other and also across the midline to the corresponding vessels of the other side. Obviously a narrow midline wound, (1), for laryngectomy, dividing only anastomotic twigs, leaves a better blood supply than a layer by layer operation as shown in Figure 2.

the larynx and trachea are reached. Retractors are used carefully so that the whole sides of the wound are retracted and not the skin alone.

5 Utmost care should be taken to minimize trauma; cutting is preferable to blunt dissection. Traumatized tissues are vulnerable and invite infection.

6 Few ligatures will be required, no large arteries are normally present in the midline (Figs. 1 and 2). Veins of considerable size may be encountered, if they cannot be drawn aside, they should be clamped before division and ligated at once. The superior and inferior laryngeal arteries or their anomalous equivalents must be ligated, and also their accompanying veins. In all of this work trauma should be carefully minimized as advised by Crowe and Broyles.

7 Muscles are not excised as in wide field laryngectomy. It is true that the muscles inserted into the laryngeal cartilages lose their insertion but they are not useless; their action after healing assists in swallowing movements and sometimes in pseudophonation. What is even more important is the fact that leaving the muscles lessens trauma and pocketing and gives good support to the pharyngeal repair. Muscular insertions into

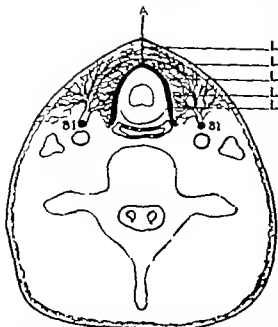


Fig. Diagrammatic horizontal representation of the blood supply of the region concerned in laryngectomy. (It does not represent frozen section at particular level, but composite schema of the different levels concerned.) The blood supply is chiefly from upper and lower lateral trunks, represented respectively L5. Obviously midline cord, A as in narrow field laryngectomy leaves better blood supply with consequent better chances for prompt healing, as compared to layer-by-layer operation (L, L, L, L, L) with laying back of large skin flaps and much hemostasis. Pending development of collateral circulation healing is retarded and pharyngostoma is favored, and sometimes even necrosis of flaps occurs.

the laryngeal cartilages are detached close to the perichondrium with least possible trauma. Detaching the perichondrium itself with insertions intact, as done by Crowe and Broyles, seems even better.

8. Mechanical aspiration of blood and secretions must be maintained as long as the cough reflex is abolished.

With the aforementioned technical features constantly in mind, the operator may use his favorite plan of removal of the larynx. He may remove it from above downward or from below upward as preferred.

9. Not having expected any muscles good strong support for the pharyngeal repair can be built up. The stiffening of the repaired wall is increased by the thyroid perichondrium if the plan of Crowe and Broyles be employed.

10. The median line incision without muscular excisions or pockets simplifies drainage. There is

ordinarily no need of riddling the neck with passages for drainage tubes. One median drain is usually sufficient. Crowe and Broyles use rubber tissue. Babcock prefers glass and uses continuous suction with a weak motor pump.

11. At the top of the order sheet after operation should be written "This patient must not be given atropine or opiates without written authorization of the chief. If this is not done, the deplorable hospital routine of postoperative sedatives will inevitably be followed. Water in adequate daily amounts to prevent dehydration must be specified. It is given through the nasal feeding tube that is placed at operation. Food is unimportant for the first day but water is vital. After the first day vitamins and a balanced diet are essential for prompt healing.

12. Dressings should be heavy enough only to cushion the pressure needed for obliteration of pockets. A frequent change of gauze prevents stagnation and the flow of sterile serum cleanses the wound. Catheter aspiration of the trachea by the nurse prevents obstructive atelectasis. If the percussion note becomes impaired over any area of either lung notwithstanding catheter aspiration of the trachea and main bronchi, bronchoscopy must be done for clearing the airway. Under no circumstances is a diagnosis of pneumonia warranted without a bronchoscopic examination to exclude obstructive atelectasis. If a tracheal cannula is worn, the outer cannula must be changed at least once a day and the inner cannula as often as necessary. The Chevalier L. Jackson cannulas without entangling projections are best because they prevent fars and jerks on the wound in wiping away coughed-up secretions.

POSTOPERATIVE COMPLICATIONS OF LARYNGECTOMY

The appalling frequency and high mortality of complications in the early days of laryngectomy have been greatly diminished by modern technique of wide field laryngectomy and still further lessened by the narrow field technique, yet it cannot be said that complications have been eliminated altogether. It seems warranted to state that the narrow field procedure is seldom followed by secondary hemorrhage, virulent infection, serious sepsis requiring opening of the wound, necrosis, sloughing, breaking down of the pharyngeal repair, pharyngeal fistula, or pharyngostoma. Pulmonary complications require separate consideration.

Pneumonia and atelectasis as complications of laryngectomy. Pneumonia as the internist understands the term, is, today, one of the rarest com-

lications of laryngectomy In the early years of this operation, according to the records, about 40 per cent of the patients died of "pneumonia," "double pneumonia," or "collapse." The bronchoscope has shown that recorded signs and symptoms of these conditions have been produced in patients who had obstructive atelectasis without pneumonia and, further, that all of the signs and symptoms disappeared after plugs of thickened secretion were bronchoscopically removed (8, 9, 11-15). Because of its bearing today on the problems of laryngectomy and its postoperative care, it seems important to make an analysis of the factors concerned in the obstructive atelectasis that so frequently was, and occasionally is still mistaken for pneumonia. First, let us consider the operative procedure and after-care practiced in the early days. They have been enumerated thus

"The pall of the earlier days still hung over the operation. In the usual technic the patient was kept profoundly under the anesthetic because surgeons believed light anesthesia involved risk of sudden reflex cardiac arrest. The practice was to start with a deep anesthesia which totally abolished the cough reflex for two or three hours, then to give opiates which abolished it for a number of days longer. Though full physiological cough cannot be carried out without glottic co-operation, the laryngectomized patient can, by forced expiratory blast, clear his tracheobronchial tree through the cannula if his secretions are not thickened by opium and atropine and all his sensory nerve endings and reflexes are not drugged asleep. Strange as it may seem, many operators deliberately gave large doses of atropine for the purpose of drying up the saliva with no thought of the harm to the lungs. Stagnation of pulmonary secretions and clots for two or three days resulted from the drugging asleep of the watchdog of the lungs" (11)

Let us consider some of the factors that were concerned in the desiccation of the bronchial secretions and consequent obstructive atelectasis due to plug formation

1. *Ether* was blamed for causing postoperative "pneumonia" by direct irritation. It probably never caused pneumonia in this way. It is a factor in bronchial plug formation in 2 different ways (a) It causes hypersecretion. The bronchoscope has shown that when there is hypersecretion the secretions increase in coagulability because of an increase in fibrin. (b) Ether is a powerful respiratory stimulant, during a long operation the respiratory centers are greatly fatigued, a long period of reactivity weakened respiration follows. This means stagnation of the excessive endobronchial secretion. Stagnation favors thickening and coagulation.

2. *Dry air*. Thickening of endobronchial secretions and plug formation are favored by the dry air of the average hospital, in winter time hospital

air is desiccating (11, 12, 14). This desiccation is of course increased by the fact that the inspired air in the laryngectomized patient is taken in directly through the neck without the humidifying effect of the nasal passages.

3. *Dehydrated condition of the patient* favored drying of endobronchial secretions. The patient was deprived of water because the operator feared the necessary swallowing movements and pharyngeal distention might start a leak in the pharyngeal repair, or the water reaching the stomach might cause equally disastrous vomiting. This latter was almost certain to happen because of the opiates given. The nasal feeding tube advocated in 1904 (10) to prevent dehydration as well as for feeding, was likewise objected to as mechanically causing nausea that was really due to opiates.

Opiates and atropine. Atropine was routinely used (a) separately for its inhibitory effect on oral secretions that often threaten to break through the pharyngeal repair, (b) to lessen bronchial hypersecretion of ether inhalation, (c), as an adjuvant to morphine. Unquestionably atropine favors thickening of bronchial secretions and formation of plugs that cause obstructive atelectasis. Morphine or any other opiate has the effect of drying the bronchial secretions, depressing respiration, and inhibiting the cough reflex, thus favoring stagnation and drying (6, 7, 8, 9, 15).

Abolition of the cough reflex supplied the important element of time for the coagulation, thickening, and increased viscosity of secretions and thus favored formation of obstructive masses or plugs. Uninhibited cough, by the hecic blast and tussive squeeze would have expelled the fluid secretions before they had time to undergo an increase of viscosity. By all the classic techniques the cough reflex is abolished by the anesthetic during the operation, this abolition is perpetuated by the postoperative administration of morphine and atropine.

Recurrence. Ultimate statistics are not yet available in sufficient quantity for even approximately conclusive determination of relative percentages of recurrence in wide field and narrow field laryngectomies, respectively. So far as early recurrences are concerned they are fewer after the narrow field than after the wide field operation. This, however, does not indicate that the narrow field technique is necessarily more efficacious, it was used only in less advanced cases and those not showing evidence of glandular metastases.

SUMMARY
The following statements though dogmatic in form are offered as postulates

The standard technique of laryngectomy is based upon extensive removal of lymphatic metastases. The advisability of attempting to remove such metastases seems questionable but, granting that it is advisable, are we justified in opening the whole front of the neck to get out the larynx of a patient who has no glandular involvement? Let us call this technique a wide field operation. Unquestionably it is the easiest way to operate because of its wide access. Its disadvantages are extensive trauma, much interruption of blood supply, poorly nourished flaps, retarded healing, and all 4 of these disadvantages combine to favor breaking down of pharyngeal repair and formation of pharyngostoma. Is it not better to do a narrow field operation taking out the larynx through a midline incision and leaving the apparently uninvolved glands to be sealed up by irradiation if they should later show evidence of involvement? The history of the surgical treatment of cancer of the larynx shows that operators have closely followed the principles developed for dealing with cancer of the breast where anatomical and pathological conditions are quite different. In dealing with mammary cancer a narrow field operation would be indefensible. In cancer of the larynx too advanced for laryngofissure, but still intrinsic and free from evidence of cervical adenopathy a narrow field operation seems to have many advantages.

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THE DIAGNOSIS AND SURGICAL MANAGEMENT OF CHRONIC SINUSITIS

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THE correct diagnosis of chronic disease in the paranasal sinuses can be arrived at only by a definite and systematic routine of study. Failure to adopt such a plan will add unnecessary handicap to one's efforts and may even lead one astray entirely. It is only by the strict observance of every detail that an accurate diagnosis can be obtained. Any inaccuracy in diagnosis will undoubtedly lead to improper treatment. This is one factor which is responsible for the attitude of the laity and of many physicians, who are opposed to nasal and sinus surgery or treatment. The so called conservative surgery on the nose and sinuses is, I believe, a larger factor in the distribution of the propaganda that "once a sinus, always a sinus." The removal of the septum, a turbinate, or a polyp for the cure of chronic sinusitis is as efficient as a skin incision for the cure of appendicitis. Unless the abdominal cavity is entered and the diseased appendix removed, a cure cannot be expected. Likewise unless the sinus cavity or cavities are opened and the diseased tissue completely removed, good results cannot be obtained.

NEED OF ACCURATE DIAGNOSIS

First in importance in any diagnostic study is a well taken history. This will provide all the facts about the onset and the progress of the disease. It will eliminate or lead to suspicion allergy or allergic tendency. This is a most important point and should always be given due consideration, otherwise too many disappointments will result.

The symptoms elicited in the history are all significant. Headache or pain is a frequent symptom, occurring in about 60 per cent of the patients. However, the fact must not be overlooked that pain is not an essential symp-

tom of chronic sinus disease. The worst types of sinusitis can exist for years without any pain whatsoever. This is especially true in ethmoid and antral involvement, less likely to occur in frontal or sphenoidal infection. While the pain varies greatly in severity, location, and character, it still has some diagnostic significance. There may be days or weeks of complete freedom from pain, followed by days or weeks of excruciating pain, which morphine will relieve only partially. It may be moderately or mildly severe and described as a sense of pressure or fullness inside the head, or of a band drawn tightly around the head. It may be constant, or intermittent and neuralgic in character. It may be frontal, parietal, occipital, or all over the head, or referred to the ear or throat and larynx. The intermittent or neuralgic type of pain usually exhibits one characteristic. It begins during the morning hours or the patient may be awakened with it. It grows in severity and intensity for 2 or 3 hours, and then gradually subsides completely, so that towards evening and at night the patient is absolutely free of pain. It recurs at the same time and in the same location the next day, and every day as long as the attack lasts. The diffuse, generalized headache, whether occurring in the frontal, parietal, or occipital region, shows constancy only in that it recurs in the same location and shows no tendency to migrate.

Location, character, and severity of the pain are not always significant of the sinus or sinuses involved, or of the degree of involvement. It is very important to bear this fact in mind so that a healthy sinus will not be opened unnecessarily, because of a diagnosis arrived at through pain localization. Frontal headaches are due much less frequently to frontal sinusitis than to ethmoidal or antral involvement. The vast majority of patients complain of frontal headaches, while only 2 or 3 per cent have frontal sinusitis. Pain in the

occipital region and referred down the back of the neck is most frequently due to sphenoidal sinusitis. Pains in the frontal region in and about the eye over the parietal region, or pain referred to the ear and mastoid region, or the throat and larynx are almost always ethmoidal and maxillary in origin and are due most frequently to sphenopalatine ganglion irritation.

Nasal or postnasal discharge is the most frequent complaint. While annoying or disagreeable it is not likely to be a compelling reason in the search for relief. In a small percentage of patients it is the principal symptom. In others it is more or less taken for granted, considered normal and natural and not mentioned until the question is asked. Between 80 to 90 per cent complain of post nasal dripping, about 40 to 50 per cent of anterior nasal discharge either unilateral or bilateral. The amount and character of discharge varies greatly. The patient may soil from one to a dozen or more handkerchiefs a day. The discharge is usually frankly purulent or mucopurulent. It may be constant or intermittent with varying periods of freedom. Each exacerbation or recurrence of the discharge is frequently considered a "fresh cold" by the individual. If recurrences are not accompanied or characterized by a purulent or mucopurulent discharge allergy should always be suspected.

Nasal obstruction accompanies about 50 per cent of cases of chronic sinusitis. This may be due to deflected septum, very thick, tenacious discharge, swelling of the nasal mucous membrane and turbinates, polyp formation, or a combination of any or all of them.

About 30 per cent of individuals suffering from chronic sinusitis will have pulmonary symptoms or complications. Frequently recurring attacks of acute bronchitis, chronic bronchitis, a dry hacking cough, a productive cough, bronchiectasis, or bronchial asthma will be present. Of course a certain number of cases of asthma have an allergic background but not all. Too many cases have been cured by sinus surgery and remained cured to consider all asthmas as being entirely allergic in origin. It is generally agreed that almost all cases of bronchiectasis have an associated

chronic sinusitis. It is not generally accepted, but I believe it is equally true, that all cases of pneumonia either bronchial or lobar the terminal and postoperative types excepted have an associated sinusitis. This may be either an acute infection or an acute exacerbation of a chronic infection.

About 10 per cent of patients with chronic sinusitis will have gastro-intestinal symptoms or complications, nausea, vomiting, diarrhea, fever and pain, either general or localized in the region of the appendix or gall bladder. These symptoms may be mild or very severe. There may be just a mild nausea without vomiting. Vomiting may be mild, occasional, or constant and pernicious. I have had one death from pernicious vomiting. Autopsy showed no pathology except a very extensive chronic pansinusitis. In several cases the pain was so localized in the lower right quadrant that appendectomy was considered but not done. In all cases of pulmonary and gastro-intestinal symptoms, there must be some mechanism other than the aspiration or swallowing of secretions, as mentioned in most textbooks and periodicals. There are far too many persons, suffering from chronic sinus disease, who aspirate and swallow secretions for years and years and still remain symptomless. Others will develop eye, ear, heart, kidney, cerebral, or joint complications but remain free from pulmonary or gastro-intestinal symptoms.

Most physiologists tell us that the most accessible place to irritate the vagus nerve is through the nasal mucous membrane. Therefore, a toxic neuritis of the vagus nerve from the infection present in the sinuses seems quite plausible. Selective and specific action of this toxin on the various fibers of the vagus, determine the subsequent chain of symptoms. If the sensory fibers are irritated pulmonary symptoms will result. If the motor fibers are irritated, gastro-intestinal symptoms will result and if the sympathetic fibers are irritated some heart symptoms such as tachycardia, bradycardia, angina, or pseudo-angina may be the result. The very prompt relief or even complete disappearance of these symptoms after appropriate treatment, together with the fact that this most often occurs long before the nasal discharge ceases during which time the

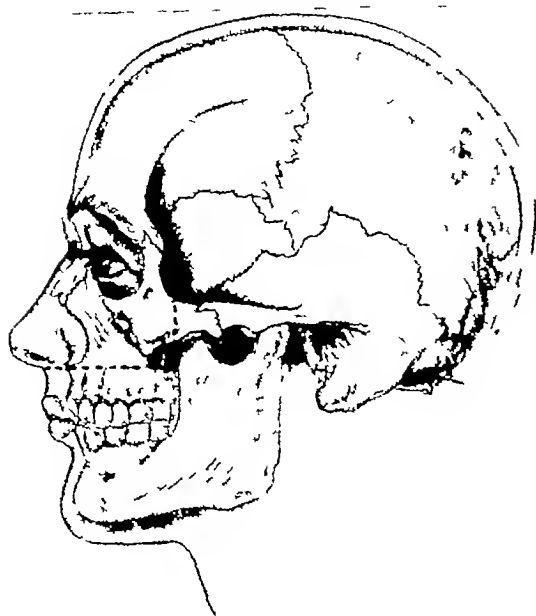


Fig 1 The site for injection of the sphenopalatine ganglion is marked with an X. It is at the junction of imaginary lines, one running horizontally backward on a level with the tip of the nose, meeting a perpendicular line along the posterior border of the zygoma. A 2 inch needle is used, directed inward, slightly upward and backward

individual still has ample opportunity to aspirate or swallow secretions, strongly supports this view

There are undoubtedly a great many other factors, some of which we do not know, that enter into the cause of these conditions. The type, character, and virulence of the attacking organism, the age and resistance of the individual, natural or acquired immunity, inherited tendencies, allergy, and what not, all play some part. Otherwise how can we account for the wide variety of symptoms, or lack of symptoms, and the great variations in the pathology present? Why should one individual have a dry, hacking, or a productive cough, without demonstrable lung pathology, while others have a mild or extensive bronchiectasis or asthma, and still others have gastro-intestinal or cardiac symptoms? With the knowledge that these symptoms and sequelæ do occur in connection with sinusitis, it is my opinion that all cases of frank or obscure pulmonary disease, in which tuberculosis, occupational diseases, and foreign body

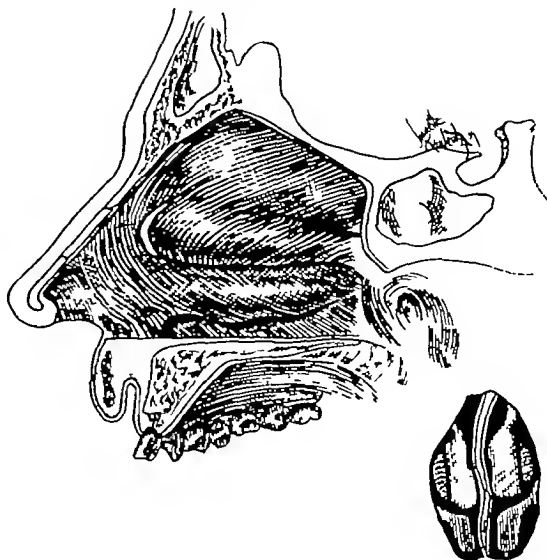


Fig 2 Incision for partial resection of the middle turbinate, from above downward along the anterior border. Inset shows, heavily shaded lateral portion, which is to be removed, leaving balance of turbinate and mucous membrane intact.

have been excluded, and many cases of obscure gastro-intestinal diseases, should have a thorough examination of the nose and sinuses, including roentgenograms, to determine the presence or absence of disease therein

Symptoms other than pain, referable to the eye, are present in about 1 per cent of the cases. These are manifested mostly by disturbances of vision. It may vary from slight blurring or dimness of vision to complete blindness and involve one or both eyes. The pathology present is not constant. It may be a retrobulbar neuritis, an optic neuritis, retinitis, choreoretinitis, iritis, etc. Orbital cellulitis and abscess occur rather infrequently and are due either to erosion through the bone or extension by way of the blood stream

Symptoms referable to the ear occur in about 2 per cent of the cases. This may be manifested in a number of ways: pain, vertigo, catarrhal or suppurative otitis media, and deafness. The pain or earache may be due to a suppurative otitis media, which will be demonstrated plainly by characteristic changes in the appearance of the tympanic membrane. Many times, however, the patient will complain of severe earache, either in the ear, or

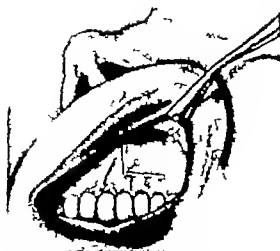


Fig. 3. A right angle incision through mucous membrane and periosteum. Each arm of the incision is between $\frac{1}{2}$ and $\frac{3}{4}$ inches long.

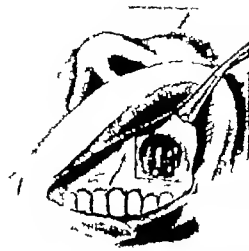


Fig. 4. Macropieristoma retracted up and acid out, and Bony all removed showing thickened, polypoid mucous membrane.

over the mastoid, without any changes noticeable in the drum membrane. This is referred almost always through the sphenopalatine ganglion and can be controlled by cocaineization in the ganglion area. The deafness may be the result of an auditory neuritis, otitis, or a combination of the two.

Symptoms due to focal infections such as arthritis, nephritis, pyelitis, peripheral neuritis, etc. occurred in about 2 per cent of the cases in my series. This number I am quite sure is too small not because sinusitis was overlooked as a cause of focal infections, but because it was not even considered. The teeth, tonsils, prostate, gall bladder and appendix are frequently examined and eliminated but the sinuses are forgotten. Much more emphasis should be placed upon the fact that chronic sinusitis can and does cause any or all of the diseases known to be or suspected of being due to focal infection. Many times the sinusitis is absolutely silent or asymptomatic and is discovered only after an intensive search for the focus responsible for the patient's general condition. These facts should be remembered so that the sinuses will, at least, be considered in any search for focal infections.

Symptoms referable to the brain and its coverings occur in a small percentage of cases. Meningitis and brain abscess are due either

to direct extension through the bone or by way of the blood or lymph channels. Encephalitis and various mental and nervous diseases are undoubtedly due to toxic absorption.

Fever is a variable symptom. In the acute infections and acute exacerbations of the chronic cases it may be high depending on the virulence and character of the invading organism, and the disease which it accompanies, such as scarlet fever, influenza, or erysipelas. In chronic sinusitis fever is usually absent, when present, it is usually of the low grade type of evening temperature ranging from 99 to 100 degrees. It may be present for months and is most often suspected of being tuberculous in origin. This is especially true if there is an associated cough. It is frequently aggravated by exercise of a rather mild nature. I have had several patients in whom temperatures would rise to 103 or 104 degrees after a short brisk walk.

Next in importance is a complete rhinolaryngological examination. Anterior and posterior rhinoscopy, examination of the sinus orifices and nasopharynx with the nasopharyngoscope to determine which sinuses are involved and the character and amount of secretion escaping therefrom should be performed. Transillumination of the sinuses is very valuable if done in an absolutely dark

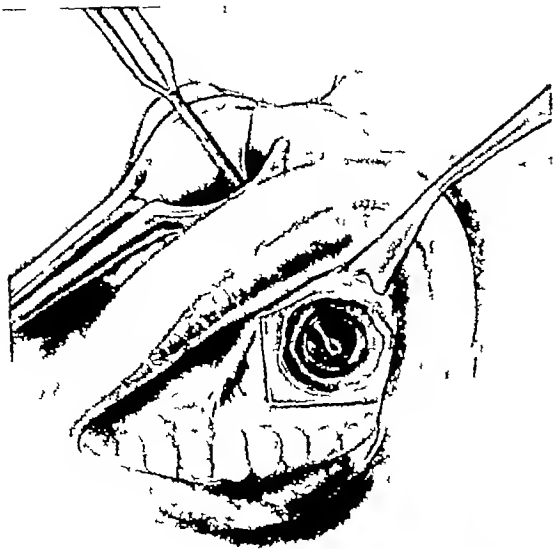


Fig 5 A splendid view of the ethmosphenoid region is obtained by looking through either the nasal speculum or the antral opening in the canine fossa

room. It will reveal whether or not the disease is bilateral or unilateral, or if one side is more involved than the other. However, it has been my experience that a negative or very clear transillumination does not always rule out sinus disease. If the history and symptoms are strongly suggestive of sinus disease, roentgenograms should be taken. A well made, expertly interpreted roentgenogram is undoubtedly the most important, single diagnostic aid at our command in the study of sinus disease. Certainly every case in which operation is anticipated should have a roentgenogram. In cases where the existing pathology is so evident, that roentgenograms are not a necessary aid in diagnosis, they are absolutely essential as a guide during the operation. In my opinion, doing an operation upon sinuses which have not been made the subject of a careful roentgenographic study is like starting on an automobile or boat trip without a map or compass.

The presence or absence of the frontal sinuses, the relative size and shape of the antrum, the size and extensions, either supra-orbital or infra-orbital of the ethmoid, and the size and extensions of the sphenoids, can be portrayed definitely in most instances. Most

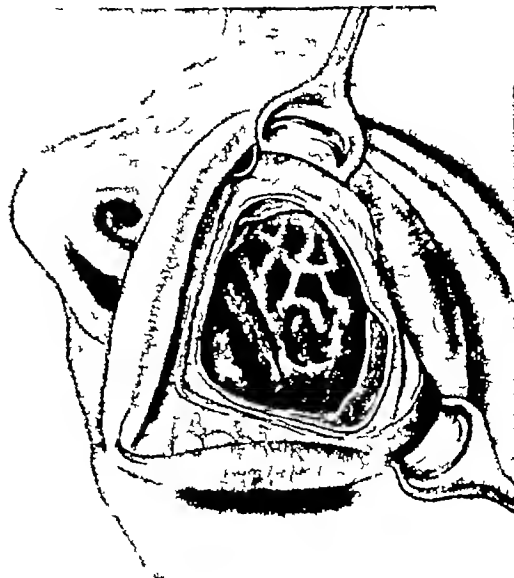


Fig 6 An enlarged, exaggerated view of the ethmoid cells

of this information can be obtained from a single, anteroposterior roentgenogram made in the Waters position. The patient is placed in a sitting position, using an upright head, Bucky diaphragm tube stand, posterior anterior view, with the chin resting against the plate holder, nose $\frac{1}{2}$ inch away, mouth open 1 inch, focal plate distance 30 inches, central ray perpendicular to the center of the film.

TREATMENT

After the diagnosis is made the problem of treatment arises. As this paper is concerned only with surgical management, other methods of treatment will not be discussed. The age, the physical condition of the patient, the presence of some serious disease such as myocarditis, diabetes, syphilis, tuberculosis, anemia or leukemia, all will have some influence in management. The operation selected should be one that will remove all of the diseased tissue from the sinus or sinuses involved, and leave the nasal cavity anatomically and physiologically normal. The type of surgery necessary in each individual case is often a very delicate problem.

There are too many ill advised attempts to do some type of intranasal surgery for the cure of extensive chronic sinus disease. These are doomed to almost certain failure. The ana-

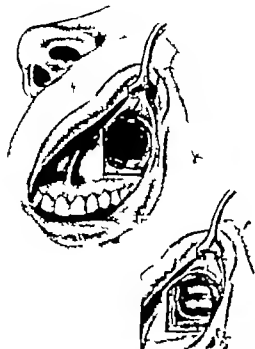


Fig. 7 Dotted line shows the inverted U-shaped incision in the naso-antral flap. Lower shows flap turned downward into the antrum and the free border of the inferior turbinate.

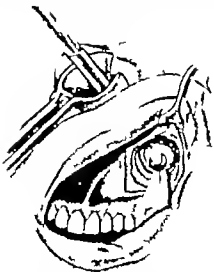


Fig. 8 Sinuses packed with supracalcine gauze. Free anterior end threaded through eye of rag curette.



Fig. 9 Curette removed from antrum by downward and outward pressure on the handle, removing free end of gauze from the sinuses through the nostril.

tomical variations in size shape and extension make it practically impossible to reach these safely by any intranasal method of approach. The most that can be accomplished is improved drainage. The pathological changes in the mucosa and bone of chronically infected sinuses is of such a nature that simple drainage is not adequate treatment. Intranasal attempts to dilate or enlarge the frontal duct is possibly the most common and most serious mistake of all. It almost always results in a cicatricial stenosis with complete obstruction or obliteration of the duct. Many of the so called radical sinus operations are radical only from the standpoint of normal tissue destruction. All of the turbinates and large amounts of nasal mucosa are removed apparently without thought or regard to the patient's future welfare. Many operations of the Caldwell Luc type are called radical. They may be radical but they certainly are not complete.

Chronic frontal sinusitis occurs rather infrequently or in about a per cent of the cases. When it does occur an external operation is

necessary, the type and extent of which will be determined by the existing pathology and the judgment of the operating surgeon. When we have a chronic pansinusitis, a combined external frontal and transantraethmosphenoidectomy is the operation of choice.

The operation which I wish to present is very satisfactory in 95 per cent of the cases requiring surgical treatment. It is a combined intranasal, transantraethmosphenoidectomy. It can be done either under local or general anesthesia. If the disease is bilateral, both sides may be operated upon under the one anesthetic. I usually combine local and general anesthesia. The patient is given a hypodermic of morphine, 1/6 grain, atropine, 1/150 grain, 30 minutes prior to operation. After the patient is completely anesthetized by gas and ether, the mask is removed. A gauze sponge is placed in the nasopharynx to prevent blood and secretions from running into the throat and from being aspirated or swallowed. A Branower breathing tube is placed in the mouth. This tube is very satisfactory in every way. It has fittings for the attachment of sterile rubber tubing on each side out of the way of the operator. Ether vapor is supplied through one side, oxygen through the other. It keeps the tongue out of the pharynx and allows a free exchange of air. The nose and face are thoroughly washed with alcohol (Fig 1). Then both sphenopalatine ganglia are injected with 2 cubic centimeters of 1/2 per cent novocain solution, to which has been added one drop of adrenalin, 1:1000, to each dram of novocain. The septal mucous membrane and turbinates are injected with the same solution in exactly the same manner as for local anesthesia. This reduces bleeding to a minimum, prevents or minimizes shock, and helps to control postoperative pain. Both canine fossæ are injected with a small amount of the same solution.

If the nasal septum has not been resected, previously or is deflected, especially in the upper and posterior part where it will interfere with free and easy access to the ethmoid and sphenoid sinuses, it is resected. This procedure may be criticized because of the possibility of infection in the submucous field. Over a period of years and several hundred

operations I have never seen any untoward results. On the other hand, where the nasal septum was not resected, it interfered greatly with proper exposure during operation and with postoperative treatments. If the nasal entrance is obstructed or narrowed in any manner, this should be corrected by a plastic operation. Unless the patient has a perfectly functioning nose after operation, the result will not be satisfactory, either to the surgeon or the patient. Ample breathing space is absolutely essential in attaining these results. What is to be gained by doing a beautiful submucous resection, providing ventilation and drainage for the sinuses, and leaving a closed nasal entrance through which the patient can get no air?

The next step is to displace the middle turbinate away from the outer wall. It should never be removed. It is the only protection for the cribiform plate. So long as it is in place, and we stay underneath or external to its upper attachment, there is absolutely no danger of injuring the cribiform plate. If the middle turbinate is enlarged, it can be partially resected (Fig 2). The ideal way, is to take a sharp knife, split the turbinate from top to bottom and remove as much of the lateral portion as necessary, preserving the medial portion. This preserves all or most of the normal mucous membrane covering the turbinate.

The ethmoid cells are now entered and the anterior wall removed with a small ethmoid rongeur. Using a Mosher curette, more of the anterior cells are broken down. A small strip of gauze, saturated with adrenalin, 1:1000, is placed into the opened ethmoid to remain there until removed through the posterior superior wall of the antrum.

The antrum is opened through the canine fossa (Fig 3). A right angled incision is used, this provides better exposure with minimum trauma to the tissues. The periosteum is elevated upward and outward and held by a retractor. A small bone drill is used to enter the anterior antral wall, enlarged by a Kerrison rongeur to provide sufficient exposure. The opening in the bony wall should be extended as far forward and downward as possible to obliterate the angle formed by the

anterior and nasal walls (Fig 4). In extending the opening upward and inward care should be taken not to injure the infra-orbital nerve. The mucous membrane is now loosened by a small periosteal elevator beginning at the anterior inferior angle and extending in all directions until the entire mucosa is free. Many times it can be removed *en masse*. More often it is removed piece meal. It is very important that all of the lining membrane be removed. A small laryngeal mirror is used to inspect the outer and upper walls.

The bony naso-antral wall is removed next by a chisel and rongeur forceps, being very careful to preserve the membranous wall. We now have an unobstructed view of the posterior superior wall of the antrum which exposes the anterior ethmoid cells. With a small biting forceps or a curette an opening is made into the ethmoid and enlarged with Hajek biting forceps. The gauze strip placed in the ethmoid cells intranasally is removed through the antrum. All of the postantral and infra-orbital ethmoidal cells are exposed and completely exenterated under direct vision (Fig 5). Next we place a deep Killian nasal speculum behind the middle turbinate and retract it medially. Using Hajek forceps and Coakley curettes, all of the remaining cells can be removed under the middle turbinate. By looking through the speculum and the antral opening you get an unexcelled exposure of the entire ethmoid labyrinth (Fig 6). This brings into view the anterior wall of the sphenoid. This may be opened either through the natural ostium or by a small curette. The entire anterior wall is then removed with Hajek forceps. The contents are removed with a small Coakley curette. An inverted u-shaped incision is made in the membranous naso-antral wall and the flap turned down into the antrum (Fig 7). This prevents subsequent closure of the opening and provides constant drainage at a point near the floor

The sphenoid ethmoid, and antrum are now converted into one large, smooth cavity with adequate openings for drainage and treatment well protected by the middle and inferior turbinates.

A large ring curette is introduced into the antrum under the inferior turbinate and held high against the anterior wall (Fig 8). Narrow strip gauze impregnated with nupercaline ointment, is now inserted through the canine fossa, into the sphenoid then the ethmoid then the antrum and the end threaded into the ring of the curette, and withdrawn through the naso-antral opening into the nostril (Fig 9). Both nostrils are packed with nupercaline gauze. This gauze minimizes the discomfort of the packing, not only while it is in place but also during removal. The incision is closed by two silk or linen sutures. The nasopharyngeal pack is removed and the patient returned to bed.

All packing is removed in 24 hours. Irrigations are started after 48 hours, and stitches are removed after 7 days. The average time required for the operation is 2 hours. The average hospitalization is 10 days, and the average duration of treatment is ordinarily 10 weeks.

CONCLUSIONS

Surgery of the sinuses is a major procedure therefore, thorough examination of the patient is absolutely essential. Complete physical blood, and urine examinations should be demanded. Cultures of the secretions and pathological examination of the tissue removed from the sinuses at the time of operation should be routine. Minute attention to every detail spells the difference between success and failure, either in the diagnosis or treatment. Nothing should be done hurriedly, neither the history the examination, nor the operation, because anything that is worth doing, is worth doing well.

INDICATIONS FOR SURGICAL TREATMENT IN SINUSITIS

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THE indications for any form of surgical treatment in sinusitis are based upon, first, an accurate diagnosis and, second, a carefully arrived at decision that conservative treatment will either be futile or perhaps uneconomic. It is fundamental that an accurate diagnosis depends upon a comprehensive history and a thorough examination. The possibilities of migraine, allergic conditions, ocular disturbances, intracranial lesions, or general systemic disease must always be kept in mind. The ophthalmologist, the internist, and the laboratory may furnish valuable information which may prevent placing undue emphasis upon some existing abnormality in the sinuses, to the neglect of other possible causes of the patient's condition. Good roentgenograms are indispensable in order to evaluate thoroughly the condition of the sinuses. Occasionally we hear criticisms of an increased tendency to depend upon laboratory aids and consultations for a diagnosis. This may be justified at times, but I cannot subscribe to the all efficient infallibility of any one specialist. Looking into one window does not reveal the condition of the entire house. To the statement that these procedures unduly increase the expense to the patient, let me suggest that this added cost can be absorbed nicely by a similar solicitous attitude on the part of the surgeon in regard to his own fee.

Too often the diagnosis of sinusitis is hastily made upon mere assumption or inaccurate observation. The medical discovery of the paranasal sinuses and the realization of their potentialities in relation to disease, like most geographical discoveries, led inevitably to a period of more or less exploitation. With hasty, inaccurate diagnoses and stereotyped therapy routinely applied, is there any wonder that the effectiveness of treatment for sinusitis has often been viewed with skepticism, both by the practitioner and the layman? This naturally gave rise to a deep-seated prejudice against operations on the sinuses, and we heard the oft-repeated saying, "Once a sinus, always a sinus." Of course, in a strict sense, this is true, as rarely do we obliterate a sinus. The abdominal surgeon removes an infected gall bladder or an appendix, but in operating upon the sinuses we

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do not remove them. We drain them, break down and remove cell partitions, and remove diseased lining membranes, but we still have the sinuses to deal with after operation. If we have carefully evaluated the condition, studied the clinical pathology, and considered its probable effect upon the patient, we may arrive at a conclusion that some form of surgical treatment to promote drainage or remove hopelessly diseased tissue would prove sufficiently beneficial to the patient to make the procedure worth while. If surgical treatment is decided upon, the particular type of operation should be selected according to the demands of the individual case. We must fit the operation to the patient not the patient to the operation. Under such conditions surgical measures may be distinctly indicated and, if correctly carried out, are usually justified by the results.

Acute sinusitis In acute sinusitis surgical treatment is rarely called for. Most cases are self-limited and will recover with conservative treatment, while surgical interference may possibly provoke unnecessary complications. An exception to this might be those cases in which continued severe pain, purulent discharge, and the roentgenogram suggest either a delay in resolution or inadequate drainage. In these cases such minor procedures as infraction of the middle turbinate, turbinotomy, opening of the agger nasi cell, or irrigation of the antrum may be helpful. Often the necessity for employing these procedures varies inversely with the thoroughness of early conservative treatment and may be obviated by a stricter regimen of therapy.

Acute sinusitis with complications In acute sinusitis of the fulminating type, early surgical interference may be necessary. Fortunately, these cases are rare. They are generally seen in younger people and the worst cases follow swimming. There is usually severe pain, tenderness, fever, evidence of sepsis, purulent nasal discharge, and sometimes swelling. In these cases we should endeavor to obtain adequate drainage with a minimum of bone work. Intranasal antrotomy may provide sufficient drainage for the antrum, but with a fulminating infection of the fronto-ethmoidal sinuses, external incision and drainage are preferable. At this stage there should be no attempt to exenterate the ethmoid cells. After the acute condition has subsided, if resolution does

not take place, an ethmoidectomy, intranasal or external depending upon the conditions, may be performed. Orbital abscess, secondary to ethmoiditis, should be drained externally in a similar fashion.

Perhaps the most serious of these complications is osteomyelitis with its possible sequelae of brain abscess and meningitis. Fever and pain may or may not be present. There is external swelling, sometimes with a discharging fistula. The one most valuable diagnostic sign, as pointed out by Mosher (4) is edema. It is usually from 7 to 10 days before the infection can be demonstrated by roentgenogram, and the area of involvement will be from 1 to 2 inches beyond what is shown on the film. Mosher (3) has proved the importance of the diploic veins, which run both upwards to the periosteum and inwards to the dura. Retrograde thrombophlebitis of these veins carries the infection upward and accounts for the characteristic pitting edema. The roentgenogram may be of value in early cases by demonstrating the presence of these diploic veins with their potentialities. Early and radical operation is indicated. The skull plate from well beyond the line of edema should be removed and the skin flaps left open for drainage.

Acute exacerbations of chronic sinusitis. Surgical treatment of chronic sinusitis during an acute exacerbation is generally contra-indicated, unless some impending complication makes interference necessary. In such a case one should strive for adequate drainage with such minimum of bone work as is consistent with the condition.

Chronic sinusitis. For practical purposes we may consider 2 forms of chronic sinusitis: the purulent, characterized by a purulent nasal discharge, and the hyperplastic, with polyps and obstruction. According to Eggston, the former is atrophic, fibrotic, sclerotic, or arteriosclerotic, with an associated condensing osteitis and is due to involvement of the afferent blood vessels while the latter is characterized by thickened and edematous changes in the mucous membrane, rarefaction and osteoporosis of bone, with inflammatory infiltration of the veins and lymphatics. There may be all gradations of these or a combination of both may occur even in the same sinus.

Purulent. Many cases of purulent maxillary sinusitis are of dental origin, due to infected molar or premolar teeth. Sometimes this becomes evident only following extraction, when the patient develops a purulent nasal discharge, usually foul in character. If the condition does not resolve after removal of the dental infection and conservative treatment, irrigations of the antrum or a large

intranasal antrostomy generally suffices. In some cases there may be sufficient pathology in the floor of the antrum to necessitate operation through the canine fossa. The presence of an alveolar fistula in the site of an extracted tooth is an indication for early surgical interference. Most of these will close following a large intranasal antrostomy but some will require external operation or plastic closure of fistula. Most cases of dental origin will respond to intranasal drainage.

Many cases of purulent sinusitis may improve with proper attention to associated metabolic or endocrine disturbances. In children, correction of dietary errors and removal of tonsils and adenoids will frequently be followed by resolution. Persistence of discharge, periodic headache, nasal obstruction, laryngeal and pulmonary symptoms, ocular disturbances or evidence of focal infection may indicate the advisability of surgical interference. The position of the antrum, acting as a possible reservoir for pus draining from the ethmoid cells, and the high location of its own ostium make it the least amenable to conservative treatment. Consequently this is the sinus which requires surgery most often. An intranasal antrostomy may cause the infection to subside. If this proves futile, or if there is evidence of marked mucosal pathology which in all probability would not resolve following simple antrostomy radical operation, such as the Caldwell-Luc, is indicated. Submucous resection of a thickened, or highly deviated septum, or the removal of the middle turbinate *in toto* or in part, may improve aeration and drainage of the ethmoid cells. Persistence of suppuration may indicate the advisability of an intranasal ethmoid operation. Generally this is facilitated by doing a preliminary submucous resection of the septum. As a rule the sphenoidal sinus is included in the operation as it is usually involved. Less frequently one may see cases of sphenoidal suppuration with postnasal discharge and sometimes ocular symptoms but little evidence of ethmoid involvement. In such cases removal of the anterior wall of the sphenoid may be advisable if irrigations or displacement have proved ineffective. Unless complicated by some such condition as osteoma, mucocele or involvement of the optic walls, operation upon the frontal sinus in this type of case is seldom indicated. The frontal sinus is usually afforded adequate drainage by the ethmoid operation, as it has the advantage of gravity. Interference with the nasofrontal duct may be productive of future trouble. Mosher urged preserving its virginity. Should conditions demand surgical treatment, the external fronto-ethmoidectomy is to be preferred.

Chronic sinusitis — hyperplastic Perhaps the hyperplastic type of chronic sinusitis is that most frequently encountered. Many of these are allergic. In these, indicated allergic treatment must be carried out. When marked hyperplastic changes in the sinus mucosa are present, this often will not be sufficient. Secondary bacterial involvement seems prone to occur in these cases. Generally a combination of allergic treatment and radical surgery gives the best results. While it is better to avoid surgical measures during acute manifestations of allergy, operative treatment may be decidedly beneficial when these factors are under control.

Unless contra-indicated by such factors as the extremes of age or some associated disease condition, the radical type of operation is to be preferred with this form of sinusitis. With marked nasal obstruction, polyposis, and roentgenographic evidence of well established mucosal changes in the antrum, operation by the canine fossa route with removal of the diseased lining would be indicated. This may be combined with the trans-antral operation on the ethmoids if desired. Any anterior cells which are not accessible may be opened intranasally. If ethmoidectomy is done as a separate operation, I prefer the intranasal procedure, despite the growing popularity of the external operation. In competent hands I think the former is preferable from the patient's viewpoint. Tilley says, "That in seeking to 'make the punishment fit the crime,' with few exceptions the intranasal route should always be chosen in the first instance." Some operators routinely open the sphenoidal sinus in every ethmoid operation, but here again it may be well to individualize. If it does not appear to be infected, it may be left alone at least for the time being. If definitely involved with a polypoid lining, it should be opened as widely as possible. The sphenoidal sinus is often a problem after operation due to tendency to closure from scar tissue. Theoretically the removal of its floor is ideal in order to prevent this closure, but actually this result cannot always be accomplished.

The external fronto-ethmoidectomy should be reserved for those cases which defy simpler methods. Lynch, himself, said, "When all else fails, try this." While the open operation undoubtedly allows a more thorough exenteration than the intranasal ethmoid, the after-results are not always all that one could desire. A completely satisfactory radical operation on the frontal sinus, from the patient's point of view, is something to be desired, but not always attained. Many patients are far happier with a not quite-so thorough intranasal

ethmoidectomy, even though it may possibly need some revision later. The external fronto-ethmoidectomy should be employed in those cases in which intranasal or transantral operation has failed, when frontal sinus pathology must be removed, not merely drained, or when complications demand an external approach.

The particular type of operation should depend upon the conditions of the individual case. In most cases the Lynch type of operation answers very well and has the advantage of not disturbing the anterior frontal wall. In cases with very large frontal sinuses, however, the Kilian operation may be more efficient. Certain cases might justify an obliterating operation, even with the resulting deformity. In the so called conservative operations which open the sinus externally and attempt to enlarge the duct by means of burrs and rasps, it is often difficult to maintain the opening. Therefore, if there is sufficient pathology to warrant external operation, or if the frontal sinus will not resolve after an intranasal ethmoidectomy, the combined external fronto-ethmoid operation seems preferable.

SUMMARY AND CONCLUSIONS

- 1 The decision that surgical treatment is indicated should be based upon careful, thorough study of the individual case, with consideration of possible associated disease, or environmental factors, and the conclusion that more conservative measures would be futile. The probable effect of the existing pathology upon the patient should be compared to the expected improvement following operation. The simpler procedures, if at all consistent with the clinical picture, are to be preferred. Many times, from the patient's point of view, graded operations and secondary operations are preferable. When radical measures are indicated they should be carried out as thoroughly as is consistent with the safety and future comfort of the patient.

- 2 Surgical interference is rarely indicated in acute sinusitis.

- 3 Adequate drainage with a minimum of bone work should be the objective in fulminating sinusitis. Early and radical removal of the skull plate is indicated in osteomyelitis.

- 4 Most antral cases of dental origin will subside following removal of the dental infection and intranasal antrotomy.

- 5 In chronic purulent sinusitis underlying factors should be given proper consideration. Intranasal drainage procedures may cause resolution. If unsuccessful, more radical methods may be indicated.

6 In chronic hyperplastic sinusitis the question of allergy must be considered. A combination of allergic treatment and rational surgery often gives the best results. Radical types of operation are usually more effective with this form of sinusitis.

7 The external fronto-ethmoidectomy should be reserved for those cases which defy simpler methods.

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NON-SURGICAL THERAPY IN ACUTE SINUS DISEASE

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IN discussing non-surgical therapy in acute sinus disease, I realize there is nothing original to put forth. The average practitioner looks rather disdainfully on this specialty and is reluctant to refer his patients with sinus disease until some complication has arisen. We often hear patients say that they do not wish any surgery done. Their impression is, once a sinus, always a sinus, and that usually one operation is but the beginning of many.

There are almost as many ways of treating acute sinus disease as there are men treating it much confusion has arisen regarding treatment, and it would be futile to attempt to specify any definite method.

Physiology. In the treatment of acute sinusitis, we must not lose sight of the physiological principles which govern the cure of it. Sir St. Clair Thomson, in his observation on the action of cilia, states that the mucous and ciliary action combined, form the first line of defense of the air passages. The arrest of the inspired organisms is due to the secretion of healthy mucus and these organisms are then ejected by the action of the ciliated epithelium. This ciliary action is not influenced by gravity. The sinuses are lined throughout with cilia and their action is always in the direction of the orifice of the opening they are guarding. Slight trauma causes arrest of the cilia. Intranasal temperature has some effect on their movements. In obstructive sinusitis, the cilia are active but does not necessarily arrest ciliary action.

Etiology. Predisposing factors in the causation of sinus disease are many some of which we might mention here, such as improper hygiene with a general lowering of resistance. Long continuance of untreated allergic conditions predisposes the sufferer to infection by causing poor ventilation and drainage. Then, too, endocrine dysfunction is a factor. The hot, dry air in most buildings during the winter season dries the mucous membranes. The old swimming hole nowadays called the pool where the water is so highly chlorinated that it causes severe irritation to mucous membranes, permits infection to take place readily.

Of the local factors to be considered is edema of the mucous membrane interfering with ventilation and drainage. Structural changes in the nostrils, as hypertrophied turbinates or deviated septum, hypertrophied tonsils and adenoids with narrowed nasal openings, anterior and posterior frequent head colds and tonsillitis, and the acute infectious diseases as measles, scarlet fever, influenza, etc. These are but a few of the constitutional factors in the etiology of sinus disease.

Symptoms. The symptoms are so well known that all that there is scarcely any need of enumerating them. However it is when the prodromal symptoms of dryness of the nasopharynx, followed by sneezing stuffiness of the nostrils, and a general feeling of malaise appear that early treatment is most effectual. This is the time when we may possibly be able to terminate the inflammation by desiccation instead of allowing it to go on to resolution. Suggest to the patient that he rest in bed and he will promptly tell you. I am not sick enough to go to bed.

Pathology Inflammation is the succession of changes which occur in living tissue, provided the injury is not of such a degree as to destroy structure and vitality at once. This is naturally accompanied with changes in the vessels and migration of fluids and solids therefrom with changes in the perivascular tissues. Suppuration is always preceded by a catarrhal inflammation.

The usual organisms found are the streptococci, staphylococci, pneumococci, and the various bacilli. A large number of eosinophiles present in the nasal secretion suggest allergy.

In the acute exacerbation of chronic sinus disease, conditions are somewhat different. We have more or less of a permanent pathology, as for instance deviated septum, hypertrophied turbinates, chronic nasopharyngitis, etc., and here we may have a fulminating type of infection.

Diagnosis The history is of the utmost significance. Any history of a contagious or allergic disturbance must be taken into consideration. Secretion from the nostrils should be examined for type of organism, and if we find an overabundance of eosinophiles, it is very suggestive of allergy.

Celsus described acute inflammation as redness and heat with swelling and pain, or, as set forth in sinus disease—heat, pain, swelling, disordered function, and possibly discoloration. In general, rest and gentle treatment of the mucous membranes should be prescribed for this acute type and the body should be helped in part to return to normal.

In the diagnosis of acute sinus disease, the methods are well known to all, and there is little need of going into this phase of the subject in detail. To aid in the diagnosis, we have, anterior and posterior rhinoscopy, roentgenography, and the nasopharyngoscope. These are all familiar.

Treatment To attempt to enumerate the various types of treatment would indeed be a task, for there is no specific cure, either by medicine, surgery, or biology discovered for sinus disease. In the treatment we should (1) help the first line of defense, and (2) combat the infection.

The termination of inflammation may be followed by a return of tissue to health, and this may take place by delitescence or resolution. By delitescence is meant the abrupt termination at an early stage, resolution is the gradual disappearance of symptoms when the inflammation has passed through its regular stages.

Kyle's dictum years ago, "treat those mucous membranes gently," still holds true and should be adhered to more than it is. In treating the acute sinus infection we must not lose sight of

the physiological principles which govern the cure of it. Proetz has found that healthy sphenoids and ethmoids empty themselves completely in 96 hours, frontals a little faster, and the maxillary sinus a trifle slower. It would seem, therefore, that the general principles in the treatment of sinus disease would be proper drainage, aeration, and general support.

Suffice it to say that the treatment of any underlying systemic disease of which the sinusitis is a complication should be carried out. Investigation of the patient as a whole, rather than simply treating the local manifestation, is of the utmost importance. We should look into the bacterial infection, local reactions, allergy, glandular dysfunction, interference with normal ciliary action, nasal obstruction, tonsils and adenoids, the acute infectious fevers, and frequency of colds, and the seasonal nasal allergy and endocrine imbalance must not be overlooked. The otolaryngologist must, therefore, have a good general idea of medicine as well as that of his specialty.

Allergy plays a very important part in the treatment of sinus disease, and often the co-operation of the allergist is of great value to us.

Negus attempts to help the normal defenses by clearing the bacteria from a sinus, for example by lavage, so that they no longer multiply in numbers sufficient to produce lactic acid in harmful concentration, while the diminished alkali reserve in the body can be re-adjusted by the oral administration of alkali. The influence of suitable as well as adequate ventilation should play a major part in the therapy of acute sinus disease.

Fenton states, "Beyond some simple alkalization there is no decided proof that any special diet will do much for nasal infections." Some authorities state that acids or excess of calcium ions slow, and that alkaline or potassium ions hasten, the rate of action of the cilia.

There has been a mass of research material on the subject of drugs and their action on cilia, and here we might mention a few. Distilled water causes slowing of the cilia. Therefore, we should use some isotonic solution. Drugs which clog up the mucous covering interfere with the cilia, these should be avoided, as for instance, mercurochrome. A 5 per cent solution of cocaine has no paralyzing effect, stronger solutions do. Menthol solutions should not be stronger than 5 per cent.

The vast majority of patients do not care to go to bed upon the first sign of an acute cold but prefer to wait until they are "good and sick."

The following routine of treatment is then established. The patient is put to bed, this diminishes the amount of blood sent to the affected part and lessens the force of circulation. Some form of opiate helps this immeasurably. Ventilation and drainage are accomplished by the use of a cocaine spray or isotonic solution of ephedrine sulphate which is applied locally. Constitutionally heat, cathartics, diaphoretics, etc. play their part in the successful treatment of acute sinus disease.

Sulfanilamide is a valuable agent in acute streptococcal infections, but it should not be used indiscriminately. Camlrol has been used with gratifying results by Coates. These measures may be reinforced with antitoxins and antibodies such as opsonins, phagocytes, bacterolymins, vitamins, and calcium. Roentgenograms and dia-

thermy have not proved as satisfactory as in other acute infections.

Each individual dealing with acute sinus disease must have a most comprehensive understanding of the whole science of medicine and when infection does not improve some surgical procedure may be necessary.

CONCLUSIONS

No specific treatment has yet been found that will cure all sinus diseases.

Prompt, thorough treatment of acute conditions prevents serious complications.

Sulfanilamide in streptococcal infections is a valuable remedy but should not be used indiscriminately.

The co-operation of the allergist is of great value.

THE VOICE AFTER LARYNGOFISSURE AND LARYNGECTOMY FOR CANCER OF THE LARYNX

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VOICE is the chief consideration in the treatment of most benign laryngeal conditions. In malignant conditions voice must obviously be relegated to second place, because the first and most urgent indication is to cure the cancer (2). It is necessary to explain this to the patient and his family, so that they may readjust their attitude, and accept whatever voice impairment may be entailed in the procedure required to obtain the proper prospect of cure. However, the fact remains that one of the things that the patient is most anxious to know before consenting to the necessary operation, is whether or not he will lose his voice. Many people believe that removal of the vocal cords will make it impossible for them to talk, and the majority of those to whom total laryngectomy is advised are very skeptical when we assure them that they will soon learn a new way of talking after the larynx is removed. We explain that voice is relatively unimportant, as compared with curing the inevitably fatal, if untreated, cancer, but it is very comforting to the patient, conducive to his fit condition for operation, as well as a consolation to his family, to know that he will not be doomed to use the sign language or a pad and pencil the rest of his life to express himself.

It seemed to me that it would be interesting and helpful to conduct a special follow-up on patients who have had the various laryngeal operations done, by sending out questionnaires regarding postoperative voice development. All living patients operated upon since 1929 were sent questionnaires. Replies were received from 51 patients who had had one or both cords removed by laryngofissure and from 30 patients on whom total laryngectomy had been performed.

THE VOICE AFTER LARYNGOFISSURE

Patients who have had one or both true cords removed by laryngofissure practically always develop a useful voice, but its quality, pitch, and carrying power vary greatly. Cicatricial "adventitious" cords develop in most cases, and in pa-

tients with good voices, generally either one good cord remains, and a good "adventitious" cord has developed with which it can approximate and vibrate, or two good "adventitious" cords have been formed to replace two cords that have been removed. Another mechanism by which a good voice can be produced is ventricular band phonation (1), which is to be regarded as undesirable when it is "usurpative," but which may afford an excellent and very efficient substitute for true cord phonation when 1 or both cords have been removed. One of the factors that is of importance in determining the character of the voice is the degree of motility present, and this in turn generally depends in some measure on how much of the arytenoid was removed and how severe the inflammatory reaction was in the crico-arytenoid joint. The presence of a granuloma may interfere seriously with the production of a good tone, and such tissue should be removed by direct laryngoscopy if it does not shrink up and disappear in a month or two after operation. Sometimes several removals are necessary. In still other cases voice is impaired by the presence of a cicatricial web across the anterior commissure.

Of 51 laryngofissure patients operated upon in the past 10 years, who have answered our questionnaire to date, 43 replied in the affirmative to the question, "Have you developed a useful voice since your operation?" In reply to the question, "Is your voice good, fair or poor," 8 replied "good," 37 "fair," and 6 "poor." A great variety of occupations were represented in the series: physicians, lawyers, bankers, salesmen, teachers, editors, machinists, clerks, electricians, merchants, farmers, business executives, and housewives. Thirty-seven of these patients stated that they had been able to resume the same work that they had done prior to operation. Forty-three were able to use the telephone and 10 stated that they were able to address groups of people, some of them qualifying the statement with the word "small." Sixteen patients could sing before operation, but only 3 claimed they could do any singing since laryngofissure.

We are now at work on a follow-up study of the postoperative appearances in the entire series, with a view to determining, if possible, what ele-

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ments are participating in the voice developed in each particular case.

SPEECH AFTER LARYNGECTOMY

The patient who has had his larynx removed or is about to have it removed is apt to be very depressed at the thought that he may never be able to talk again, but he will be cheered up at once if it is explained to him that the larynx is only one part of the speech mechanism that it provides a column of air coming up from the lungs and a pair of vibrators or vocal cords, but that it is the "moulds of speech" namely the tongue, lips, cheeks, palate, etc. which form the words. Then it is explained that it will be necessary for him to learn to collect air in his hypopharynx, esophagus, and stomach to replace the air column from the lungs and to produce tone by means of vicarious cords formed in the hypopharynx or pharynx. He will probably be very skeptical about this but one can assure him that experience has shown us how to help patients get the knack of this sort of speech, and that his course of voice lessons will be begun as soon after the operation as healing permits. Schall (4, 5) has given us 2 excellent papers on this subject and has shown that the laryngectomized patient is not a social outcast, nor in most cases is he an economic burden. Schall has found that these patients constitute a most optimistic, cheerful group neither objects of curiosity nor in most cases, recipients of charity.

These views regarding the social and economic rehabilitation of the laryngectomized patient are fully supported by the replies to our questionnaire. To date we have had replies from 30 patients operated upon during the 6 year period, and of these 18 replied "yes" to the question, "Have you learned to speak without your larynx?" Five stated that they could whisper only 6 said flatly "No."

One of the most interesting things noted in the replies to the questionnaires was the fact that in reply to this question, "Is your voice good, fair or poor?" 50 per cent of the laryngectomy patients replied "good" while only a little over 10 per cent of the laryngofissure patients replied "good" most of them said "fair." The occupations of the patients who had laryngectomies were as follows: salesmen, merchants, carpenters, army officers, physicians, laborers, steam fitters, molder, housewives, locomotive engineer, wood carver, magistrate, executive, printer, tailor, hotel proprietor, waiter, gate-tender and milkman. Seven of these patients have been able to resume the same work, wholly or partially. Among the questions asked the laryngectomized patients was whether or not they had tried to use an artificial

larynx and whether it had proved satisfactory. Only 3 had tried it, and only 2 found it satisfactory—one other said "fairly so" and still another "yes and no."

Blomson deserves a great deal of credit for the work he has done in advocating a definite course of voice instruction for laryngectomized patients. Some will not require lessons, but most will make little progress or develop hopelessly bad habits if they are not systematically taught. We have for the past several years made it our practice to begin voice lessons in each case as soon as the condition of the wound will permit and we have been obtaining excellent results. We plan now to communicate with all those who have stated in their reply to our questionnaire that they have not been able to develop a satisfactory voice and to request that they come in for instruction.

It is planned also to examine the entire series of patients with a view to determine what anatomical factors, if any influence the voice. We have seen in some cases a "pseudoglottis" resembling the true glottis to a remarkable extent while in others, who have an equally good voice it is difficult to ascertain what the vibrating structures are. There has been some question as to the advisability of leaving the epiglottis with the idea that it might aid in voice development. Personally I think this an unwise practice in most cases because of the danger of incompleteness of removal of the tumor. As a matter of fact, I doubt the essential value of the epiglottis as a vibrator because I have seen equally good voices in patients whose epiglottides have been removed.

With regard to the artificial larynx, I believe it is a mistake to have the patient try it before he has had a chance to develop a bucco-esophageal voice. I believe its use should be reserved for those who are not able after a fair trial, to develop this more natural "pseudovoice."

CONCLUSION

While voice is of secondary importance in procedures undertaken for the eradication of a malignant tumor, the reply to a questionnaire sent out to a series of patients who had had laryngofissure or laryngectomy for cancer of the larynx, showed that the majority had been able to develop useful voices and to resume their original occupation.

The majority of the patients who had developed a voice after laryngectomy considered it "good" while the majority of patients who had had laryngofissure considered their voices only "fair."

3. While many patients acquire the knack of bucco-esophageal speech spontaneously it is best

to give a systematic course of voice lessons to these patients as advocated by Morrison, just as soon as the wound is healed

4 The artificial larynx should not be tried until after the patient has made some effort to develop a voice without it

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HOW AND WHEN TO OPERATE UPON THE ETHMOID SINUSES

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THE ethmoid sinuses play an important rôle in any discussion pertaining to the nasal accessory cavities. The reason for this is quite obvious. Situated as they are between the frontal above and the maxillary sinus below with the sphenoid cavity posteriorly, it can readily be understood how an infection of one of the adjacent sinuses may affect the ethmoid, and also how an involvement within the ethmoid sinus itself may secondarily affect the other cavities. It is, therefore, well to look upon the paranasal sinuses as one system of cavities subject to the same irritation whatever it may be. Good results following nasal sinus surgery will depend largely upon the removal of the vicious circle within the ethmoid, and, in many instances, the careful removal of disease within the ethmoid will be sufficient reason for the abeyance of an inflammation of the larger cavities above and below.

The mucous membrane of the ethmoid sinus is pale, thin, flabby, easily detachable, poorly nourished, and very liable to infection. An inflammatory action, which may be of an evanescent nature in the mucous membrane of the nose, may very readily overpower the vitality of the mucous membrane of the sinuses, especially of the ethmoid. When involvement of the ethmoid sinus takes place, the mucous membrane of the middle meatus, namely, the lateral concave surface of the middle turbinate, the floor of the ethmoid, and the lateral wall of the nose opposite the middle turbinate are

first involved. The limitation of the disease to this area probably accounts for the success in treating acute and subacute infections, when cotton tampons saturated with silver preparations are placed in this region.

The predominant types of inflammation are the suppurative, the serous, and the mixed. In the suppurative variety, the mucous membrane is red, evenly swollen, rich in blood, and is firmly attached to the bone because of the presence of connective tissue proliferation. In the serous type, the mucous membrane is pale, edematous, and the poor-in-cells exudate causes connective tissue bundles to spread apart so that the exudate has free play. There is no connective tissue proliferation, except in the late stages of the disease when mixed infection enters the picture.

A patient having a serous catarrh of the ethmoid sinuses is also affected with a catarrhal inflammation of the remainder of the Schneiderian membrane. The inflammation may subside in the nose, but the lateral wall opposite the middle turbinate may remain thickened and edematous, and because of improper ventilation, the inflammation spreads to the ethmoid floor. The presence of edematous thickening of the ethmoid floor is often overlooked, inasmuch as it may be completely covered by a laterally displaced middle turbinate. A latent disease of the ethmoid follows and may remain unrecognized, because of the mild pathological changes which have taken place. It may be well to remember, however, that even in the presence of a mild disease of the ethmoid sinus, very severe symptoms may manifest themselves.

A point I wish to stress in this connection is that headache, as the result of an ethmoiditis, is not always caused by the ethmoid disease but may be the result of pressure of the edematous middle turbinate on the lateral wall of the nose, thus irritating the lateral branches of the anterior ethmoid nerve. Infraction of the middle turbinate towards the septum, and the application of trichloroacetic acid to the lateral wall of the nose and the floor of the ethmoid are often the only procedures necessary to relieve a patient of headache. The use of trichloroacetic acid and infraction of the middle turbinate may be employed with good results in the treatment of chronic ethmoiditis in children.

In making a nasal examination we are apt to pay more attention to the appearance of the hiatus semilunaris, and forget the region of the recessus sphenoidal. This recess is situated above the superior meatus and forms the interval between the posterior extremity of the superior turbinate and the anterior aspect of the body of the sphenoid. It is a shallow but well defined, triangular fossa of much clinical significance and is to the posterior group of cells what the hiatus semilunaris is to the anterior group. Inflammation of this recess, especially in subacute infections, may be the forerunner of ethmoid disease and the inflammatory products from this area may be forced easily into the posterior cells by negative air pressure at the end of inspiration. We may suspect involvement of the sphenoidal recess when the patient continues to complain of stiffness of the nose and anosmia, following an acute nasal infection, when the nasal examination shows an edematous closure of the olfactory fissure, and when the nasopharyngoscopic examination reveals a mucous plug at the posterior end of the middle turbinate. The recessus sphenoidal is treated by making repeated applications of a 30 per cent cocaine solution to the edematous olfactory fissure, after which a cotton-wrapped applicator bent at right angles and saturated with a 30 per cent solution of cocaine is applied to the region of the posterior end of the middle turbinate and then passed upward into the recess. This is followed by an application to the recess of Mandl's solution.

The question of when to operate upon the ethmoid sinuses is readily solved when we are dealing with a patient in whom other sinuses are also involved, especially when there is present an extreme polyposis. The type of inflammation in the various cavities may, however be different. There may for instance, be a suppurative within the ethmoid cells with a serous inflammation of the

frontal sinus, or there may be a purulent infection in the antrum, while the ethmoid sinuses are involved with a serous type of inflammation. The important point to remember in this connection, is that in doing a radical antrum operation, a careful inspection of the ethmoid sinuses should be made and operation proceeded with if sufficient pathological changes are found in this region. If this is not done, failure may follow the operation, inasmuch as the antrum will act as a reservoir for the infection in the ethmoid cells above. Complications are also more apt to follow the antrum operation, if the diseased ethmoid cells are overlooked. Another cause of failure is the incomplete removal of the ethmoid cells, especially those dipping down into the antrum and those extending laterally along the roof of the orbit. The latter cannot be approached except through the external route and the former may necessitate an approach through the antrum by way of the canine fossa although in many instances the downward prolongation of the ethmoid sinuses may be reached if a part of the middle mental wall of the antrum is removed at the time of doing an intranasal ethmoid operation.

We are prone to think of doing an ethmoid operation in the presence of disease in this area only but it is my contention based on clinical experience, that quite a few patients with recurrent attacks of headache have an anatomical variation present in the ethmoid region which is the cause. A mild systemic derangement or an allergic reaction may result in edematous swelling of the mucous membrane, thereby closing the nasofrontal duct, and may be the cause of a vacuum headache. Pathological changes, other than the transient edema, are rarely found in these patients, and when continued closure of the nasofrontal duct is present, the headache may be a constant one. I have seen patients who have suffered with headache for 15 or 20 years, who were relieved after the removal of the anatomical obstruction within the ethmoid labyrinth, and in whom, at the time of the ethmoid operation, no gross pathological changes could be found. This experience has convinced me that an investigation of the ethmoid sinuses in an operative exploratory manner is more often indicated, but should be done only after all other means have been tried to relieve the patient.

The anatomical variations are more varied and are greater in number than in any other region of similar size in the body. The pressure of the middle turbinate alone against the lateral wall of the nose, or a high deviation of the septum may be sufficient reason for the presence of a headache.

Other anatomical variations which may be found are as follows (1) An apposition of the bulla ethmoidalis with the uncinat process, (2) a large bulla or uncinat cell, (3) upward displacement of an infundibular cell into the frontal sinus, thereby closing the nasofrontal duct and preventing the passage of a sound into the frontal sinus, (4) a tortuous nasofrontal duct, and (5) laterally displaced ethmo-orbital cells

An attempt should always be made to correct the anatomical variation by means of intranasal ethmoid surgery and, if success is not attained, to proceed at a later date by means of the external route. In the majority of instances, the intranasal operation will suffice. We cannot dispute the fact that anatomical variations are frequently observed during the performance of an ethmoid operation for the removal of gross pathological changes. It is questionable, in my mind, whether the headache in these patients was caused by the anatomical variation or by the disease within the sinus.

It is often very difficult to decide whether the ethmoid sinus alone is affected, or whether or not other sinuses are also involved, and, if so, whether the ethmoid disease is the cause of the infection in adjacent cavities. The various diagnostic means at our command, plus careful and repeated examinations, will help to solve the problem. Chronic purulent ethmoiditis is rarely satisfactorily treated in a conservative manner. Surgery is usually necessary. The serous type, based on an allergic background, is often amenable to treatment without surgery. If satisfactory results do not follow desensitization treatment, surgical intervention is indicated, and should not be postponed too long, for the reason that there are many allergic individuals who require operative interference before a satisfactory result is obtained.

I firmly believe that the intranasal ethmoid operation does not receive the attention it deserves by most rhinologists. Septum operations are done with the hope that the mere removal of the nasal obstruction will be sufficient to care for a chronic ethmoiditis. That this does happen occasionally will not be denied, but that it often fails to produce the desired result must also be admitted. I have seen innumerable patients who had a septum operation performed elsewhere, and who were not relieved of their symptoms until an intranasal ethmoid operation was done. It is, in my opinion, good surgical judgment at least to infract the middle turbinate at the time of doing a septum operation, and if pathological changes are seen on the ethmoid floor, to proceed with the ethmoid operation intranasally. To do this, and at the same time preserve the middle turbinate,

is, in my opinion, a conservative operation. An intranasal ethmoid operation should never be done during the period of an acute involvement, especially if a *Streptococcus hemolyticus* infection is present. If an operation is indicated at this time, because of severe symptoms or an intra-ocular or meningeal complication, it must be done extranasally. The removal of a part or the whole of the middle turbinate, during the stage of an acute infection, is dangerous. The division of the olfactory sheath, when this is done, allows for direct pathway of the infection to the brain. If sufficient drainage cannot be established because of a deviated septum, one should not hesitate to correct the septal deformity and infract the middle turbinate after all measures have been tried to relieve the patient.

Following an ethmoid operation, we may occasionally see an acute flare-up of a latent antrum infection, inasmuch as an ethmoiditis may often be associated with slight changes in the antrum, which do not become manifest until after operation on the ethmoid. I have seen this happen less frequently if part of the middle meatal wall of the antrum is removed at the time of doing an intranasal ethmoid operation. When this is done, there is less likelihood of edema of the lateral wall of the nose causing closure of the ostium, with retention of secretions within the antrum cavity. Furthermore, should an acute exacerbation of a dormant antrum disease occur, irrigation is easily done through the wide, middle, meatal opening. Another good reason for removing a part of the middle, meatal wall is that thus one can reach the downward displaced inferior hiatus cells.

There seems to be a difference of opinion among rhinologists as to the removal of the middle turbinate. In my estimation, it should be preserved, if possible, its removal should depend on the width of the nose, on its size, and on the pathological changes which may have affected it. If there is much hypertrophy, or if polypi are confined to the concave side of the middle turbinate, a part may be removed on its lateral aspect. When the middle turbinate cannot be made to occupy a medial position after infraction, a small incision made high up into the lateral attachment will tend to keep it in good position.

OPERATIVE PROCEDURE

At the first step of the intranasal operation, the uncinat process is removed with knife or punch forceps. If difficulty is experienced in passing a sound into the nasofrontal duct, the cells lying anterior to the duct are curetted or removed with a forceps. After the bulla ethmoidalis is opened,

the remaining ethmoid cells are removed with an upward biting forceps, which is of such small size that it can be used also to probe the various cells, as one proceeds with their removal. This small forceps is very satisfactory and safe, so that in many instances the entire intranasal operation can be done without using any other instrument.

We are probably agreed that very seldom can a complete ethmoid operation be done intranasally chiefly because of the lateral and upward prolongations of the cells. This does not mean that one should desist in operating intranasally inasmuch as drainage and ventilation with patency of the nasofrontal duct following operation may relieve the patient. It is true there may still be present a slight nasal discharge but this is of little inconvenience to the patient. If the headache from which he has suffered for many years has disappeared. If the skiagram shows the presence of laterally displaced ethmoid cells, the patient should be told that if intranasal measures fail to relieve the headache, an external surgical approach may be necessary. When the skiagram shows no orbital prolongation of the ethmoid sinus, we may expect better results following the endonasal measure. One thing must always be borne in mind, namely that good results are not obtained immediately following the operation. Granulation tissue and edematous mucous membrane in the region of the operation must be cured for either by applying a 5 to 10 per cent solution of nitrate of silver or by removing the offending tissue with a punch forceps. We must also remember that the nasal mucous membrane has been involved in the process, and some time is required to establish a normally functioning membrane after the irritant has been removed. As has been well said, "A chronic disease requires a chronic remedy." The middle turbinate must remain in midline, and post-operative displacement may be found necessary.

The external ethmoid operation, in my opinion, is indicated only after the intranasal procedure has failed to relieve the patient the exception is an intra-orbital meningeal complication. Severe symptoms manifesting themselves during an acute exacerbation of a chronic ethmoiditis may also require extranasal surgery. The appearance of much pus coming from the nasofrontal duct during an intranasal ethmoid operation may require an immediate external operation.

Space will not permit a detailed description of the external ethmoid operation. The pertinent facts which I wish to bring to your attention are the following:

1. The operation is done with a local anesthetic; nasal edema of the parts prevents its use.

2. Before making the external incision, a mucous membrane flap of the lateral wall of the nose is made. This flap is dissected downward, with its base lying over the upper edge of the inferior turbinate. After the operation is completed the flap is placed upward and covers the remaining portion of ascending process of superior maxilla.

3. After the ethmoid cells have been taken care of the greater portion of the ascending process of the superior maxilla is removed. This, I consider an important part of the technique, as it usually insures patency of the nasofrontal duct.

4. The posterior portion of the lamina papyracea is preserved, if possible, so that prolapse of the orbital tissue does not follow.

5. A large part of the nasal bone is removed.

6. The mucous membrane of the posterior wall of the nasofrontal duct is left untouched, unless gross pathological changes are present there.

7. The processus frontalis is carefully reduced in size with a flat chisel until it is on a level with the medial wall.

8. If the mucous membrane of the anterior inner wall of the frontal sinus is not too thick, a flap is made with the base of the flap medially placed so that it may be carried downward over the remaining portion of the processus frontalis.

Complete excision of the ethmoid cells is important. The posterior laterally displaced ethmoid sinuses, which are the most difficult to reach, are cured for with small, curved curettes. If the mucous membrane of the sphenoid has undergone hyperplastic changes, it is dislodged with small, curved elevators. In some cases, we have been able to preserve the middle turbinate. A balloon tube is placed in the region of the newly formed nasofrontal duct and is allowed to remain for 3 days. There is less danger of the flaps being disturbed when this form of dressing is used.

CONCLUSIONS

One of the important problems confronting the rhinologist is the proper surgical approach to the nasal accessory sinuses. In many instances, the key to the situation lies in the ethmoid sinuses. A careful study of this region will uncover many times an unsuspected latent disease. A carefully done intranasal ethmoidectomy is more often indicated and should be the operation of choice especially when a mild pathological change in the ethmoid sinuses is present which eventually, if left undisturbed will produce changes in adjacent cavities. To give the ethmoid sinuses the attention they deserve will be the means of procuring better results and of preventing nasal sinus surgery from falling into disrepute.

SYMPOSIUM: CANCER

SURGICAL TREATMENT OF CANCER OF THE TONGUE

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BEFORE the advent of irradiation therapy, surgery was the sole accepted method of treating cancer of the tongue. This consisted of various forms of cauterization, the removal by the scalpel of the primary lesion as a partial, hemi, or total glossectomy, and in addition any structures invaded by cancer adjacent to the tongue.

In many surgical clinics some type of neck dissection also was done. This varied from a simple excision of one or more groups of neck nodes, on one or both sides of the neck, to a complete dissection *en masse* of nodes in one or both sides. These procedures were usually the ones followed whether nodes were present or absent, and whether in an operable or advanced stage of the disease. The methods varied but little, except as to certain technical surgical points, such as whether the procedure was carried out in one or in several stages, and whether the primary lesion was removed before or after neck dissection.

With the introduction of irradiation therapy, a better understanding of the peculiarities of the disease, the histological grading of tumors, and studies into radiosensitivity and radioresistance, treatment procedure has become considerably modified and in many instances has been completely changed.

The trend in the main has been for more conservative surgery, and yet at the same time in some clinics the opinion still prevails that surgery is the method of choice in all except a minor selected group and in the hopeless cases. Opposed to these are those who believe that irradiation is the major method of treatment, and that surgery is a mere adjunct or accessory factor.

A survey of the literature shows no uniformity of opinion, and statistics are most confusing and in many places are very misleading in their deductions.

It is fair to say, however, that surgery and irradiation have now proved such complementary agents, that in the great majority of cases the one

is very dependent upon the other for the most efficient care and to assure the most comfort to the patient. Both the ambitious surgeon and the radiotherapist still overestimate their own fields too often at the expense of the other. No one can denounce the results of irradiation or of surgery, but in a disease with so many varied clinical and pathological aspects, it appears that neither field occupies priority over the other.

With due respect to the trained surgeon and to the radiotherapist, this paper will deal primarily with the surgical aspects of the disease, but certain radiological points will have to be brought into the picture. Factors that seem important in the decision for surgical intervention, as gleaned from clinics where larger groups of cases have been studied, and also from the personal experiences of the author, will be presented.

A consideration of the treatment of lingual cancer involves 2 major problems: (1) that of the treatment of the primary lesion, and (2) that of the treatment of the associated paths of extension of the disease.

PRIMARY LINGUAL CANCER

In regard to primary lingual cancer, we have 2 points to consider: (1) how the disease can be prevented, and (2) the method of treatment to be employed when once the disease is present.

Prevention of the disease. It is estimated by various authors (3) that about 50 to 75 per cent of lingual growths can be prevented by care of precancerous lesions, and that leucoplacia alone accounts for about 35 per cent of all buccal cancers. Under such circumstances, all precancerous lesions, as leucoplacia, fissures, ulcers, warts, or questionable local inflammatory processes should be looked upon as probable inevitable cancers and should be removed.

Removal is best accomplished, and at the greater comfort and safety of the patient, by some type of surgical procedure in preference to the use of radium. This may be by excision with the scalpel, electrosurgical excision, or desiccation.

It is dangerous to temporize with the continued application of caustics in questionable lesions, and

such procedure is to be condemned. All questionable cancers should be looked upon as actual cancers until proved by biopsy specimen, and should be removed widely *en masse* wherever possible. Bloodgood states as follows: "Whenever it is possible to completely remove the local lesion without mutilation of tissue, there is every advantage in having the biopsy specimen consist of the entire lesion."

Treatment of primary lingual cancer. When it is fully established that lingual cancer has developed, it becomes a problem for individual appraisal for treatment on its own merits. No routine procedure can be applied to all cases. Each case is one for individual study and individual care. Inadequate study, procrastination, and failure of adequate removal when once it has been fully established that cancer is present convert many into failures that would otherwise be successes. Failure and success are usually in proportion to adequate and inadequate initial therapeutic procedure.

A study of the literature on lingual cancer presents many interesting facts that should form some basis upon which to consider treatment in most cases. It is admitted that no hard and fast rules can be laid down. Therapy is changing and advancing, and this is especially true in the field of irradiation.

Anatomy of the tongue. To begin with an anatomical study of the tongue is important. From Ewing's writings we find that the surface epithelium of the tongue is quite varied in different locations and under different pathological conditions. Normally the upper surface and the tip of the tongue is covered with adult squamous epithelium which, when cancer develops, tends to produce spine cells, pearls, and keratin, with all the characteristics of adult squamous carcinoma. The lateral border or sides of the tongue are covered with a more modified transitional epithelium in the main. The posterior surface of the tongue is very irregular with adult and transitional epithelium, mucous glands, and a liberal mixture of lymphoid tissue and lympho-epithelium the latter extend at times somewhat along the lateral surface of the tongue.

Lingual cancers arising in these various types of epithelium often act quite differently in their growth capacities locally in their slowness or rapidity of dissemination, and in their response to both surgical and irradiation methods of treatment.

It is interesting to note that in the pathological tongue as in lentic glossitis, these differences in behavior may be exaggerated.

Gradation of tumors. There are those who believe that gradation of tumors in tongue cancer is of no prognostic significance. R. Phillips, from a report on tongue cancer from St. Bartholomew's Hospital, states: "The percentage of cures of tumors of Grades 1 and 2 was more than double that of tumors of Grades 3 and 4 whether the treatment was by surgery or radium."

It must be kept in mind that no two pathologists grade tumors quite alike and, therefore, there is bound to be some difference of opinion and deduction in such work.

From the standpoint of gradation of tumors, we find A. S. Morrow's cases: Grade 1, 54 per cent; Grade 2, 41 per cent; Grade 3, 4 per cent; and Grade 4, 0.

Hayes E. Martin's cases show approximately: Grade 1, 15.0 per cent; Grade 2, 55 per cent; and Grade 3, 7 per cent.

James J. Duffy's 353 cases of lateral border of the tongue cancer show: Grade 1, 21 per cent; Grade 2, 76 per cent; and Grade 3, 3 per cent.

Duffy in a series of all locations of tongue cancer shows about comparable percentages of Grade 1 and Grade 2 with his lateral border group.

These citations show a large percentage of tongue cancer to be either Grade 1 or Grade 2. They are usually looked upon as the more favorable groups for surgical removal, in that it is expected they are radioresistant, growth is slow and metastases occur less often.

Quick states, however:

Radioresistivity and grading are not exactly parallel. Grade 1 or even Grade 2 epidermoid carcinomas may be relatively radioresistant by reason of their anular apparatus even though the tumor cells are fully differentiated, or nearly so. An infected anaplastic tumor may be more radioresistant than surgical clean Grade 1 growth. A fully differentiated growth in an otherwise normal tongue varies considerably in radioresistivity from another fully differentiated growth in a leukic tongue by reason of the fibrosis and altered capillary blood supply—the result of the leukic gliosis.

Even though most cases do fall into Grades 1 and 2 the most favorable groups surgically on further analysis one would be led to believe they are not as favorable surgically as on first thought.

Raven states that node involvement in tongue cancer occurs in 69 per cent of the cases before 6 months, 42 per cent before 3 months, and 27 per cent before 2 months.

From A. S. Morrow's group of 93 cases, 60 per cent of the patients applied for treatment who had had the lesion less than 6 months. Approximately 60 per cent showed nodes present, 35 per cent of which were bilateral. Of 80 patients operated

upon in whom nodes were present, about 50 per cent showed metastasis. From this it would appear that about 50 per cent were inflammatory nodes only. In other words, about 30 per cent of the patients were admitted with metastasis, 20 per cent of which were bilateral. Ninety-five per cent of the cases were Grades 1 and 2.

Out of Martin's 322 cases of tongue cancer, 113 patients showed metastasis on admission, or about 35 per cent. Of these 322 cases, approximately 70 per cent were in Grades 1 and 2.

Duffy reports approximately 30 per cent of his patients showed metastasis on admission, approximately 20 per cent of which were bilateral, and 80 per cent of his series were Grades 1 and 2.

From these above findings, therefore, about one-third of the cases are advanced, or fairly so, on admission from the standpoint of metastasis alone, and about 80 per cent, more or less, are Grades 1 and 2 according to Morrow, Martin and Duffy.

Undoubtedly, a fairly large percentage of lingual cancer when first seen is either spread beyond the tongue, beyond the midline of the tongue, or shows metastasis, or in other words, is in an advanced stage of the disease. Morrow states that two-thirds of his surgical group were advanced in the sense of having spread beyond the tongue or to the cervical lymph nodes.

Roux-Berger, from statistics of the Curie Institute in a study of 386 cases of tongue cancer, found that 204 cases, or 58 per cent, were advanced in the sense that the lesions involved more than one-half the tongue, floor of the mouth, the whole tongue, or extended to neighboring tissues.

W. Baensch states, in his series of 55 cases, that 90 per cent were inoperable.

N. Petroff, in a series of 341 patients who applied for treatment, found 149 incurable and not suitable for treatment.

It is estimated by Duffy, in his series of 252 cases of cancer of the lateral border of the tongue, that in the more advanced group 20 per cent had spread beyond the midline, usually with extensive unilateral or bilateral metastasis.

From these reports it would appear that lingual cancer, irrespective of the grade, is advanced locally and metastasizes early and quite widely in a fairly high percentage of cases when first seen.

Location of lingual cancer. A. S. Morrow, in a series of 92 cases, reports the location of lingual cancer as: tip, 4.3 per cent, margin, anterior two-thirds, 43 per cent, margin, posterior one-third, 16.3 per cent, dorsum, 14.1 per cent, base, 5.4 per cent, undersurface, 10.8 per cent, and whole tongue, 5.4 per cent.

W. Baensch, in a series of 55 cases, reports the following: anterior portion, 50 per cent, base, 32 per cent, and lower surface, 18 per cent.

Hayes E. Martin, in a series of 322 cases, reports the location of lingual cancer as: anterior third, approximately 14.6 per cent, middle third, approximately 56 per cent, and posterior third, approximately 29.5 per cent.

The foregoing locations of cancer of the tongue furnished by these authors compare quite favorably as to the most frequent sites of the disease. Location alone, is a real factor from treatment standpoint without regard to size or gradation of tumors, accompanying infection, age and general condition of the patient, or the question of metastasis. It seems from the locations given that a fairly large percentage of tongue cancers are not the most accessible surgically. Accessibility, ease and safety of removal with adequate sacrifice of tissue which is so necessary for curability, are the most essential factors here as in all surgical cancer procedures.

Size of the lesion, or extent of the disease, undoubtedly, is of great importance in deciding the type of therapy. Surgical removal of cancer in an organ so important and so anatomically placed as is the tongue, with its surrounding adjacent vital structures, the difficulty of accessibility in the greater part, without extensive mutilation, is one for the most careful and thoughtful consideration.

Roux-Berger, from the Curie Institute, reports in 198 cases of cancer of the dorsum of the anterior two-thirds of the tongue, that the lesions were advanced in 70 cases, or 35 per cent, in the sense of the disease involving more than one-half of the tongue, extending to the floor of the mouth, or extending to contiguous structures. In 91 cases of cancer of the base of the tongue, the lesions were advanced in 68 cases, or 74.5 per cent, in the same sense of extent of involvement. In 93 cases of the undersurface of the tongue, the lesions were advanced in 66 cases, or 70 per cent, in the same sense of extent of advancement of the disease. It is interesting to note that from Moure of the Curie Institute, in an analysis of 42 cases of cancer of the tongue treated surgically alone, 13 cases or 31 per cent were lesions more than 2 centimeters in diameter but limited to one-half of the tongue, and that 8 cases or 19 per cent were lesions involving more than one-half of the tongue or floor of the mouth. Of these 21 cases, all but one showed postoperative recurrences, and there was only one 5 year cure in the 21 cases.

Most lingual cancer occurs in the advanced years of life. From various clinics the average would be about 60 years of age, the time of life

when cardiovascular and renal diseases are most common.

From these reports it would seem that major surgical procedures, the extent of which is necessary in tongue cancer might be challenged in most instances in view of the not uncommon inaccessible locations, advancement of the disease, cosmetic and functional results, the usual presence of infection, shock, the not uncommon occurrence of respiratory and cardiovascular complications and the high primary operative mortality which is 9 to 30 per cent. When one considers the low percentage of cures or 5 year end results and post operative recurrences, surgery might be further challenged. It is reported by some that surgical recurrences are as high as 50 per cent. Roux Berger in a series of 198 cancer cases of the dorsal anterior two-thirds of the tongue, found 23 per cent of the cases to be postoperative recurrences. Therefore in looking at the primary lesion from many standpoints and from the evidence that one finds in the literature, it seems that surgery alone might occupy a limited place for the cure of the primary lesion and when viewed in the light of irradiation literature it would seem to occupy a still more limited place. Undoubtedly small lingual cancers of the tip of the tongue the dorsum in its anterior half and anterior lateral margins, where accessibility is easy and wide and complete removal can be accomplished, are followed by a sufficiently high percentage of curability to warrant the use of surgery in the trained surgeon's hands. But even here, before surgery is elected, there should be reasonable hope of curability of both the primary lesion and the metastases that might be present. Even here surgery might be challenged by the radiotherapist as being no more efficient. It is questionable whether surgery alone in other lingual cancers is justifiable.

Surgical procedure in lingual cancer. When surgery is elected, the scalpel and the endotherm knife seem to be the method of choice. Plastic repair is accomplished easily with either. The endotherm knife offers the advantage of a dry field with minimal destruction of tissue and lymphatics are probably sealed by this procedure.

Wide mutilating operations in these cases beyond the borderline or question of operability are just as futile as the same group treated with large doses of irradiation. The intractable pain without cure of the disease in but rare instances, and general discomfort and disfigurement of the patient would justify the statement often made that the treatment is worse than the disease. It is still a wise providence to appreciate the limitations of any form of therapy in the cancer patient. It

would appear that surgery occupies a more reserved place than formerly but an indispensable place.

Surgery and irradiation undoubtedly are dependent upon each other for the best results in the greater number of cases, and both have a definite place in the treatment of the primary lesion. The one is complementary to the other they are best when used singly at times, and again prove advantageous when used in combination with each other.

By removing the main part of the mass surgically in the case of large bulky lesions in the posterior portions of the tongue greater access to the base of the tongue is facilitated for irradiation, and a better opportunity for cleansing purposes is at hand which is so essential to successful treatment.

Local removal of bulky recently treated lesions with radium needles or radon to avoid marked local necrosis and infection is quite necessary in a fair percentage of cases. Excision of areas of recently radiated tissue in the presence of leuko glossitis, is most important. These patients are known to tolerate radium less efficiently and are subject to early necrosis and subsequent infection because of their altered blood supply and increased fibrosis.

Excision of areas of late radiation fibrosis followed by necrosis, questionable areas of disease in late, fully radiated tissue or the group of hope less radioresistant cases, as established by a full therapeutic dose of radium, all call for some surgical procedure in their time and place. This is usually best accomplished with the endotherm knife or actual cautery and is best left wide open for cleansing purposes and as an aid for detecting suspicious recurrences. Usually hemorrhage is easily controlled and when the surgical procedure requires hemiglossectomy ligation of the lingual artery usually can be done under vision without much difficulty.

Exposure of the external carotid artery with ligation of the lingual branch, or the external carotid itself to control hemorrhage before or after radiation, is often a necessary procedure and a life-saving measure.

It is a hopeless and futile surgical attempt to remove any of the anaplastic group in the light of present-day irradiation methods. These growths are known to be aggressive locally and disseminate early and widely in most cases.

From St. Bartholomew Hospital we find in Grade 3 and Grade 4 cases that the results of surgical and irradiation procedures produce about the same percentage of cures. It would seem if

this be true, that surgery would be the more radical approach and therefore not indicated in these Groups

METASTATIC LINGUAL CANCER

Indications for operative intervention in metastatic lingual cancer are dependent upon many factors and, just as in the primary lesion, each case is one for the most thoughtful and careful appraisal as an individual problem

Primary and metastatic diseases are always dependent upon each other for the extent and type of therapy indicated. Some advise routine neck dissection in the presence and in the absence of nodes, in an operable and inoperable stage of the disease, others irradiate practically all metastases in all stages and types of the disease, and still others advise a combination of conservative surgery and irradiation therapy

The tongue is a good example in the group of intra-oral carcinomas in which no one can predict with any degree of certainty which nodes are most likely to be involved should metastasis take place, and thus be able to suggest a standardized method of routine treatment

Contralateral, bilateral, odd-position, and distant metastases are known to occur sufficiently frequently that one must be on the alert for any possibility in tongue cancer

Duffy's report on the location of metastases in tongue cancer is shown in Table I

TABLE I—LOCATION OF METASTASES IN TONGUE CANCER

	Submaxillary nodes per cent	Upper deep cervical per cent	Carotid nodes per cent	Bilateral per cent
Tip	31.6	5.3	26.4	20.9
Dorsum	6.8	59.6	13.5	20.1
Lateral border	31.5	20.0	37.1	11.4
Base	1.3	53.0	24.7	21.0

Cure reports Gordon B. New, of The Mayo Clinic, reports out of 156 traced cases of operations on cancer of the tongue, that 5 year cures were obtained in 29, or 50 per cent of 58 cases in which nodes were not involved but dissected, 19, or 52.8 per cent of 36 cases in which nodes were not involved clinically and were not dissected, 8, or 14.3 per cent of 56 cases in which nodes were involved and were dissected. For the group, 58, or 37.2 per cent were living 5 years or more after operation

A. S. Morrow reports 5 year survivals as follows: all cases, nodes not involved, 32.4 per cent, all cases, nodes involved, 11.5 per cent, the group, for all cases treated by surgery, 20 per cent

Morrow further states that the percentage of 5 year cures from bilateral dissection is more than double that obtained by unilateral operations, and results in which unilateral or bilateral node dissection was supplemented by a supraclavicular node operation were still better, namely, 50 per cent 5 year survivals

Hayes E. Martin, from a series of followed 5 year results of 290 lingual cancer cases, including a consecutive series of all cases, early, operable, inoperable, and advanced, reports 5 year survivals, all cases, 26 per cent, no metastases at any time, 5 year cures, 40 per cent, metastasis present on admission, 5 year cures, 5 per cent, and metastasis developed after admission, 5 year cures, 22 per cent

This seems to include surgical and radiological methods singly or combined. It is interesting to note the high difference in curability rate between the cases that were admitted with metastasis and those that developed metastasis after admission

One can hardly compare the results of these various authors and draw any definite conclusions, because there is no uniformity in the selection or makeup of the material, or the exact type of procedure done. Each author has his own idea of what are operable, favorable, inoperable, or advanced cases

Martin's idea is worth consideration. He advocates the need for a uniform, tabular method for reporting end-results. This he believes would overcome the many objections to the arbitrary selection of early operable or favorable cases upon which reports of cure-rate statistics are often calculated. Further that these calculations should be made rather upon consecutive material of all patients in all stages of the disease, both early and favorable, and those hopelessly advanced over a sufficiently short period during which treatment methods would not have changed materially

Despite the fact that there is no uniform method of gathering statistical data at the present time, and that it is difficult to draw any exact and definite conclusions, the literature contains pertinent facts that are worth consideration when the question of operative intervention in lingual cancer metastasis occurs

Duffy reports cervical lymph node metastases from 252 consecutive cases of carcinoma of the lateral border of the tongue, as follows: (1) No metastasis occurred in 103 of the 252 cases at any time. This would be 40.8 per cent of the cases that never developed metastasis in lingual cancer over the period studied. (2) From a series of 268 cases of all tongue cancer, 43.3 per cent never developed metastasis over the period studied

(3) The percentage of cases with no nodes on admission and which did not have nodes throughout was 60.3 per cent.

Hayes E. Martin in a 5 year study of 323 cases of tongue cancer reports (1) One hundred twenty-five cases or approximately 40 per cent showed no metastasis at any time. (2) Metastasis present on admission was found in 113 cases, or approximately 35 per cent. (3) Metastasis developed after admission in 84 cases, or approximately 26 per cent.

It is, however, interesting and fair to note that Petroff from the Institute of Oncology of Leningrad shows in a series of 192 of 347 patients who were acceptable for treatment, 40 per cent with no palpable nodes, 47 per cent with nodes that were palpable or movable, 33 per cent with nodes that were palpable or fixed, or a total of 80 per cent with nodes present. However this essay shows "no pathological reports." I am, therefore, wondering whether the presence of palpable nodes or metastases here means those microscopically proved, or whether a large percentage of these might not be simply inflammatory nodes. If so the findings might in the latter event be quite comparable to the findings of other authors in view of the fact that Morrow found that about 50 per cent of palpable nodes showed only microscopically proved disease. Duffy, Martin, and Morrow are quite in agreement with each other in such findings as to the percentage of cases with metastases.

The foregoing statistics are interesting in view of the surgical viewpoint so prevalent, that a unilateral or bilateral block dissection of nodes of the neck or some modified neck dissection, whether nodes are present or not, is indicated almost as a routine procedure in the favorable or operable cases in many surgical clinics. Their argument, in part, in favor of this is substantiated by the fact that a fair percentage of cases without palpable nodes on microscopic examination shows cancer to be present. A. S. Morrow reports that in over one-third of his cases in which nodes were not palpable microscopic analysis revealed the presence of cancer. Also, it is argued that 5 year surgical cures are over twice as high in patients without metastatic nodes, as in those with metastatic node involvement. This naturally would be expected. But how much did the surgical procedure actually contribute to this increased percentage of cure in the cases of those operated upon without metastasis in the lymph nodes. Would these results and percentages not have been virtually the same without surgical removal of those lymph nodes

From Gordon B. New's statistics, in cases in which no nodes were involved, it appears that approximately the same number of 5 year cures, or 50 per cent, are obtained whether neck dissection was done or was not done.

All this data would lead one to believe that more block dissections or neck dissections of modified type are done than is absolutely necessary in this disease. The objection might be raised, however that even though many neck dissections are done in cases where metastasis never develops, routine neck dissection should be done because it would be a life-saving measure in those who would develop metastasis had it not been done. This would be in that group of cases in which about 26 per cent, according to Martin's statistics of 200 cases, developed metastasis after admission. In this group, Martin had a 31 per cent 5 year cure which seems very favorable from the standpoint of metastasis. If we had any definite proof that routine neck dissection in this group would accomplish more than waiting to care for metastases after they develop, routine neck dissection might be accepted without question. However we have no assurance that should neck dissection be done metastasis might not occur in the operative field of the same side, beyond the operative field, in the opposite side of the neck or distantly as occasionally occurs.

According to Morrow in over 20 per cent of patients in whom hyperplastic nodes have been removed by upper node dissection, metastases developed outside the operative field in the same side, in the supraclavicular region, or in the opposite side of the neck at a later period. I assume this deduction might be an argument for a complete bilateral block dissection en masse to prevent such happening. This argument would seem an excellent one for a thorough and complete type of block dissection being advised in the presence of metastatic operable disease, but it seems that other factors might be an objection to such a routine procedure. We have no assurance that the most complete block dissection for either hyperplastic or metastatic node involvement will eliminate the possibility of disease from occurring in or beyond the operative field.

The primary lesion might still be uncontrolled or might be the seat of probable recurrence at least in a fair percentage of these cases. Duffy states that the primary disease was uncontrolled in 37.7 per cent of his 234 cases of carcinoma of the tongue. Forty-two per cent of these cases were early or borderline primary lesions which persisted in spite of treatment. Should these be those cases that were treated by radium, and I assume

they largely are, it is fair to suppose that in the best surgical hands a fair percentage of surgical cases would persist in spite of treatment. R. Phillips states that there is "an apparent superiority of radium over surgery in cases without node metastases" in cure rate of 40 and 27 per cent, respectively. Apparently, persisting primary disease would eliminate neck dissection in most of these cases. A fair percentage of these cases would also occur in the anaplastic group of tumors that are known to disseminate widely in the neck, mediastinum, and abdominal cavity and are, therefore, beyond the scope of surgical removal.

Another objection that might be raised is that the presence or absence of palpable lymph nodes cannot be depended upon as a guide to the presence or absence of metastasis. Morrow states that one-half of the cases with palpable nodes, and over one-third or 39 per cent without palpable nodes in his series showed cancer involvement on microscopic examination. Close interval observation as to the character of the lymph nodes, the care of infection in the primary lesion, its subsequent effect on the lymph nodes, and aspiration biopsy might at least to a certain extent satisfy this objection.

It is worth while to note that nodes probably do serve some protective process to the spread of tumor emboli, similar to acute inflammatory processes, and if removed when uninvolved might destroy this protective barrier. We all can probably recall cases in which distant metastases followed neck dissection, that we might think would not have occurred had neck dissection not been done. Quick states "It is my opinion that a strictly normal cervical lymph node is capable of destroying regularly a tumor cell embolus of epidermoid carcinoma, and that metastasis takes place only in a lymph node damaged by infection or of otherwise lowered resistance."

If 40 per cent of the cases in these 5 year studies never develop metastasis, and if 60 per cent of the cases that are admitted without metastasis never develop metastasis, careful observation in the 28 per cent that will develop metastasis after admission¹, and the prompt dealing with the same once metastases do occur might be more conservative and accomplish somewhere near the same percentage of cures, rather than the custom of subjecting all patients without node metastasis to such a major surgical procedure as block dissection, either unilateral or bilateral, with its attending added mortality, discomfort, and complications that may arise. Operative mortality for

neck dissections ranges between 2 and 10 per cent.

It is my personal opinion that when metastasis is not present a neck dissection is not indicated, and the patient can be cared for just as adequately when once metastases develop provided these patients are kept under strict observation. I believe that by so doing we will eliminate neck dissection in that group of odd-position metastasis high in the upper cervical group nodes, in the low supraclavicular nodes, distant nodes, and contralateral nodes that the most extensive neck dissection would probably fail to remove in most instances.

It seems reasonable that block dissection of the neck is not indicated unless the primary lesion is controlled, or shows reasonable hope that it can be controlled, also that transitional cell carcinoma and lympho-epithelioma, no matter in what stage of the disease, is a contra-indication to neck dissection. Both Duffy and Morrow report that about 20 per cent of metastases are bilateral. This also includes Grades 1 and 2 lesions. The question of surgical intervention here, in the presence of metastases, would depend upon the general condition of the patient, the life expectancy period aside from the disease itself, the question of the position, extent, and controllability of the primary lesion, the probability that operative intervention would give reasonable assurance of complete removal of the metastasis, that distant metastases could be ruled out, and that the tumor is of a highly differentiated cell type.

I personally question the advisability of bilateral block dissection, except in carefully selected cases with the above criteria as a guide when metastases are present, and can see little justification for block dissection in the absence of metastasis.

From the Curie Foundation we find these conclusions:

"Neck dissection is advised as soon as possible after the treatment of the primary lesion. Bilateral operation should be performed in all cases where the lesion has attained or passed beyond the midline."

There are other similar reports in the literature. However, it seems questionable whether primary lesions beyond the midline of the tongue promise sufficient hope for cure to warrant bilateral neck dissection. My ideas are in accord with Duffy in this regard.

When a case is selected for block dissection, it should be done with the most meticulous and painstaking care. This is no time or place for spectacular surgery. Haste often converts what might be successes into failures. It is imperative to realize at the start that the attempt is futile.

¹According to Duffy 28 per cent develop metastases after admission, and according to Martin 26 per cent.

unless it is sufficiently radical to remove all cancer bearing tissue. Once block dissection is started, it should be with the end in view of cure and not palliation.

Surgery Crile Semken Fischel and others have interpreted what is to be included in this surgical procedure.

According to Semken in brief, it should consist of removal of the platysma muscle, complete removal of the submental nodes, submaxillary salivary gland and nodes, lower pole of the parotid carotid and posterior deep cervical nodes, to below the level of the omohyoid crossing. The internal jugular vein and sternocleidomastoid muscle are not removed unless involved.

An incomplete attempt at block dissection only increases the chance of wound recurrence, destroys the vascular bed for what effect radiation might have accomplished had neck dissection not been attempted, and invites complications and discomfort to the patient. Inadequate surgery under such circumstances is far inferior to good irradiation.

I personally prefer local anesthesia in most instances. The patient can co-operate with the surgeon and there is greater tendency on the part of the surgeon for more delicate handling of tissues and less likelihood of postoperative pulmonary complications. Ether-oil rectal anesthesia, avertin etc. are ideal in certain cases in which the objection to local anesthesia is raised for very prolonged and difficult operations.

There should be no hesitancy on the part of the surgeon to remove the internal jugular vein or the sternocleidomastoid muscle when there is questionable disease in the vicinity or as an aid to thoroughness in the operative procedure.

Great care should be used to preserve vital structures common carotid artery vagus and phrenic nerves, the thoracic duct, etc. Fischel states that injury to the thoracic duct is usually of no serious import and will close in a few days time but I can recall, personally, several severed thoracic ducts with continued loss of weight and exodus of the patient.

Ligation of the external carotid artery or its branches may be indicated (1) to control primary hemorrhage and (2) as a preliminary step to partial glossectomy for the treatment of late fibrosis, infection, and necrosis, following irradiation.

The common carotid artery may have to be removed occasionally but this should only be done when the setting is most favorable for prolonged palliation, and in cases with reasonable hope of cure. The danger of cerebral complica-

tions following ligation of the common carotid artery should not be underestimated.

CONCLUSIONS

Lingual cancer metastasizes unilaterally bilaterally contralaterally and with odd-position metastases remarkably early and with sufficient frequency that one must be on the alert for many possibilities in tongue cancer.

1. Operative intervention is indicated in all precancerous lesions and suspected early lingual cancer. Complete removal of the entire lesion is advocated.

2. Early fully established lingual cancer confined to the accessible locations of the tongue may be removed by surgery if of a fully differentiated cell type in the absence of distant or bilateral metastasis, provided the general condition of the patient warrants the surgical risk, and in the event the life expectancy period aside from the disease justifies it.

3. In general, surgery is an adjunct to irradiation methods for the treatment of the tongue lesions.

4. Block dissection of the neck is indicated in fully differentiated carcinoma when the primary lesion is controlled or controllable when the metastasis is limited to one side of the neck, and is in general confined within the capsule of the node, when the position of the metastasis permits the freedom of sacrifice of surrounding tissues sufficiently to insure complete removal of the metastases, and when the patient is a good surgical risk and the expectant period of life otherwise so warrants.

5. Bilateral block dissection of the neck may be advisable in carefully selected cases.

6. Block dissection, either unilateral or bilateral is not indicated in the absence of metastasis.

7. Incomplete block dissections are responsible for many failures that otherwise might be successes in the hands of one trained in the practice rather than the mere theory of this type of major surgery.

8. There is a present day need for a more uniform tabular method of statistics in lingual cancer.

I wish to express my indebtedness to the authors quoted, and for their material to which I have referred. I trust I have not misquoted or misinterpreted their deductions.

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MALIGNANT TUMORS OF THE NERVOUS SYSTEM AND HOW TO DEAL WITH THEM

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MALIGNANT tumors of the nervous system differ from tumors elsewhere in the body in a number of respects. The general conception of a malignant tumor is one which grows more or less rapidly, metastasizes, and ultimately causes the patient's death. Benign tumors elsewhere in the body, even when very large, rarely cause death. The following facts about brain tumors constitute the difference.

1 Primary cancer of the brain is very rare. In our series of more than 950 verified brain tumors we have encountered only 3 or 4 patients who were diagnosed as primary carcinoma cases but none of these metastasized. In this series, however, we have seen 38 metastatic carcinomas. Sarcoma, though somewhat more frequent, also constitutes a very small percentage, and these may metastasize.

2 No tumor which has its origin in the brain, that is, a primary brain tumor, metastasizes.

3 Practically every patient with a brain tumor dies as a result of the growing tumor unless it is removed or destroyed. The length of time a patient may live varies considerably, depending upon the type and location of the tumor, but the ultimate outcome, without operation, is always the same.

TYPES OF TUMORS

The great majority of tumors which develop in the brain itself are some form of glioma. Almost

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all which grow from the meninges are meningiomas, and in addition, these are tumors which grow from the nerve sheaths of which the acoustic neuromas are the most common.

For the past 12 years neurological surgeons and neuropathologists have differentiated the gliomas into various groups depending upon the predominating cell type. As a result, we recognize 8 to 10 different tumor groups. At one end of the scale are those that grow rapidly, namely, the glioblastomas, also called spongioblastoma multiforme, and the medulloblastomas, while at the other end are the slow-growing tumors, or ependymomas, oligodendrogliomas, and astrocytomas.

The fact that a tumor does or does not metastasize, though one of the most important criteria of malignancy, is not the only one. The presence of mitoses and the fact that a tumor invades surrounding tissue are points that must be considered when evaluating the nature of a tumor.

The glioblastomas, if they present on the surface, may have a sharp line of demarcation, but as the surgeon gets into the depths when removing them, this line of demarcation disappears and it may be very difficult for him to distinguish normal from abnormal tissue (Fig 1). When such a tumor is examined histologically, it may be found to have many mitoses. Medulloblastomas, the one type of tumor that is extraordinarily radiosensitive, may also have a sharp line of demarcation and at times almost a capsule, but in spite of radical surgery, there are thus far only a few instances in which there has not been a recurrence. Still more radical procedures may result in a larger number of cures.

The slow-growing tumors at the other end of the scale, the ependymomas, oligodendrogliomas, and astrocytomas, often contain calcification; they may be well demarcated yet have some mitotic figures (Figs. 3 and 4).

The absolutely benign gliomas, known as astrocytomas, are encapsulated, often cystic, and rarely contain any mitoses.

Meningiomas, the tumors that grow from the meninges, are well encapsulated and as they grow they compress the brain tissue. Because they grow slowly it is sometimes years before they give rise to symptoms which bring the patient to the surgeon. A certain number fortunately not very many contain mitotic figures and grow more rapidly. These may be softer but they also have a capsule. From their gross appearance it is quite impossible to distinguish the meningiomas without mitoses from those with mitoses, though the softer consistency may make one suspicious.

The important question that arises is, Can these types of tumors be recognized clinically?

If this were possible it would be invaluable both for prognosis and treatment. There might be a way of distinguishing them: (1) By their location, on the theory that certain tumors are found in certain areas of the brain, and (2) by the symptoms to which they give rise.

There is no question that certain types of tumors develop far more frequently in some regions of the brain than in others. Glioblastomas occur almost invariably in the cerebral hemispheres. In our series of 100 glioblastomas 100 were found in the cerebrum and only 6 in the cerebellum. They may grow in any portion of the cerebral hemisphere, and there is no reliable evidence to indicate that they affect one lobe more than another. It is quite true that we see many more of these tumors in the frontal, parietal and temporal lobes than in the occipital lobe, but they occur there also. I know of no good explanation why the occipital lobe should be less frequently involved than the others, but this has been the general observation.

Medulloblastomas, the type that is radiosensitive, occur most often in children, though not infrequently in young adults. In the majority of cases they grow in the posterior fossa; yet this tumor has been encountered in the cerebrum also. In our series 53 were found in the cerebellum and only 7 in the cerebrum.

Astrocytomas, the most benign type of glioma, are very often cystic, usually there is only a cyst with a nubbins growing in the wall. In order to cure such a case this nubbins must be completely removed. Emptying the cyst is only a palliative procedure though it may give relief for many

years. One such patient in whom the cyst was merely emptied was operated upon in 1926, 14 years ago, and is still free of symptoms. On the other hand, this year I re-operated upon a young woman of 35 whose cyst I first opened 25 years ago. 8 years later I removed the nubbins of this cyst, as I thought, completely, and in 1939, 17 years afterward, she returned with symptoms due to a recurrence. It is generally claimed that this type of tumor occurs more frequently in the posterior fossa, but in our series 66 cases were found in the cerebrum and 44 in the cerebellum. The solid astrocytomas very occasionally have some calcification around the periphery of the tumor (Figs. 4, 5a and 5b).

There is another type of glioma, the unipolar spongioblastoma, not hitherto mentioned, which also develops in a definite region of the brain. These occur practically always in the midbrain, pons, and medulla. They are ill defined, and shade off imperceptibly into the surrounding normal brain substance. For this reason, though even more because of their location, these are the only tumors that everyone agrees are inoperable.

Astroblastomas, a very rare type of tumor may occur in either the cerebrum or cerebellum. They are as a rule, rapid growing tumors, but this is not always the case. For example, I removed an astroblastoma recently from a young man who had had symptoms for 3 years. A year after his symptoms began he had an exploration at another clinic, at which time a specimen was secured which showed the same histological picture as the tumor that we removed 2 years later.

Meningiomas occur anywhere in the cranial cavity but in most instances above the tentorium. In our series 104 were found in the cerebrum and 5 in the posterior fossa. They often contain calcium, which is deposited in a characteristic way making the diagnosis possible from roentgenogram (Figs. 6 and 7). Usually they grow slowly over a period of months or years, but at times develop as rapidly as some gliomas.

From what has just been said it should be evident that by the location of a tumor one cannot predict with any degree of certainty the type of tumor he will find at operation.

The second question to consider is, Can these types of tumors be determined by symptoms and signs?

The 3 most rapidly growing tumor types are the glioblastomas and the medulloblastomas, and, as I have just pointed out, the former occur most frequently in the cerebral hemispheres and the latter in the posterior fossa. Therefore one might suspect that he is dealing with 1 of these 2 types



Fig 1 Glioblastoma showing the way in which the tumor imperceptibly fades into normal tissue so that there is no clear line of demarcation

if the patient's symptoms have been present only a short time, though undoubtedly a patient may harbor a tumor for some time before it gives rise to any recognizable symptoms. Then, too, how shall one define "a short time"?

The fewest patients with brain tumors, when first seen, have had symptoms for less than 6 weeks, while the majority have had them for a considerably longer time. I have taken out meningiomas that have given symptoms for only 2 months, and have seen glioblastomas that have produced symptoms for several years. As a rule, however, a cerebral tumor that has given symptoms for only a month or two is most likely to be a glioblastoma, and a cerebellar tumor with a short history is more than likely a medulloblastoma.

Another difficulty enters into the picture. What shall we call the first symptom?



Fig 3 Characteristic loose cotton like appearance of calcification in an oligodendroglioma

Some years ago when studying the incidence of convulsions in patients with brain tumors, Dr Furlow and I found that in about one-third of all of our patients, one or more convulsions occurred often months before any other sign or symptom was noted. We believe that convulsions, either general or focal, are frequently the earliest warning of the presence of a tumor, and since they may precede all other symptoms by months or even



Fig 2 Ependymoma with very slight calcification in it opposite the arrow

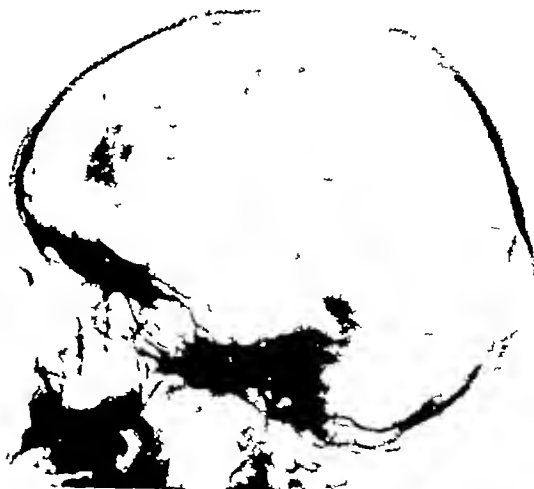


Fig 4 Calcification in a solid astrocytoma. Histological view in Figure 5b

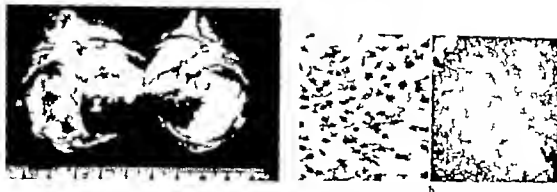


Fig. 5. a, The solid astrocytoma shown in Figure 4. b, Normal brain tissue around it. b, Typical picture of an astrocytoma, low and high power.

years, the short time we have spoken of loses much of its value.

A further question is: Do some of the symptoms and signs occur more frequently in one type of tumor than in another?

Again, it would be very helpful if they did, but unfortunately they do not. Both slow growing and rapid growing tumors may sometimes produce focal symptoms first, and at other times general signs of pressure. Either a meningioma or a glioblastoma in the precentral gyrus may have as its first symptom partial paresthesia of an extremity, or on the other hand, headache and the other signs of increased pressure.

While it is true that the symptoms may follow one another much more quickly in a rapid growing tumor, there is no rule that can be laid down on this point. Everyone has seen meningiomas attain a very great size without producing any dis-

turbance, and then quite suddenly give rise to a series of symptoms. On microscopic study of such a tumor there is no evidence that any rapid growth has recently occurred.

In children with symptoms of a cerebellar tumor, more fully 50 per cent are medulloblastomas, but as this type gives no characteristic symptoms, all one can do is to surmise what type of tumor the patient has. We cannot be positive.

A very few neurosurgeons are so conservative that purely on a chance they first treat such patients with deep therapy, hoping the tumor may be radioinactive, but in most neurosurgical clinics the feeling is that a patient should not be treated with deep roentgenotherapy until the type of tumor has been ascertained histologically. Surely this is the intelligent, constructive, and progressive way to approach the problem.

Here, then, is the situation we are faced with



Fig. 6 and 7. Two examples of calcified meningiomas.

No primary brain tumors metastasize, but a considerable number are not sharply demarcated and fully 50 per cent contain mitotic figures

Symptoms and signs do not indicate the pathological type we are dealing with, nor do any of the methods of localization roentgenography or ventriculography, help in determining them

Practically no brain tumors meet all the requirements that are generally conceded necessary to constitute malignancy. Certainly, the most important one of metastasizing is totally lacking. Brain tumors must be judged by different pathological standards. Just because they infiltrate and have mitoses they need not be considered malignant in the sense that carcinoma and sarcoma are malignant. Consequently, they should not be treated as are malignancies elsewhere in the body

TREATMENT

We all look forward to the time when some other, more effective method than surgery may be discovered for the treatment of tumors. But at the present time nothing has been found to replace surgery in the treatment of deep-seated carcinoma or brain tumors. Most surgeons believe, I know I do, that operations which are only palliative are thoroughly justifiable. Even if we cannot cure a patient, to give him a period of comfort for months or even years is well worth while. By continuing to operate upon patients whom we think we may only relieve we may be able to improve our technique to such a degree that a surgical cure may be affected. Certainly, this has been shown strikingly in surgery of carcinoma of the stomach.

I tried to make this point 2 years ago in an editorial in *SURGERY, GYNECOLOGY AND OBSTETRICS* on "The Radical Versus the Conservative Treatment of Brain Tumors." In a very recent book I have been grossly misquoted. It was said

that I advocated attempting to remove brain tumors regardless of the result for the patients, and that radical treatment in the removal of a tumor containing mitotic figures is like operating upon a carcinoma of the pancreas that has metastasized to the liver. In the light of what I have just said, such a comparison is hardly justified. Because a tumor contains mitotic figures and may not be sharply demarcated is no reason to throw up one's hands and declare all such tumors unremovable. This attitude is most unfortunate. It overemphasizes the microscopic picture, which, after all, is only the means to an end, and totally ignores surgical experience and increasing surgical skill. This is accepting defeat without even admitting the possibility of progress.

Brain tumors can be removed and we have no other means of giving patients even temporary relief except, very occasionally, with deep roentgenotherapy. Sometimes a radical removal leaves the patient with some disability. For example, removal of a tumor from the motor area may leave the patient with a partially paralyzed arm or leg, but if not removed, the tumor itself will produce such a paralysis before long. In my experience patients willingly accept such a disability, if told of it before the operation, in the hope of obtaining relief.

It is impossible, of course, to lay down hard and fast rules that will cover every case. Surgical judgment based upon experience will enable the surgeon to know how far he should go, and when he should stop, but in general, for the reasons given above, operative removal should be undertaken irrespective of the histology of a tumor. Since brain tumors do not metastasize and are entirely a local disease, our attitude in the handling of all types of brain tumors is always the same. Whenever technically possible, a brain tumor should be removed.

THE SURGICAL TREATMENT OF CARCINOMA OF THE THORACIC ESOPHAGUS

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UNTIL recently progress in the surgical treatment of esophageal carcinoma was necessarily slow. Due mainly to the rapid strides made in the fields of thoracic surgery and anesthesia, a few surgeons have been encouraged to attempt excision of the esophagus for cancer. This has resulted in an increasing number of successful resections during the past 4 or 5 years. Of the 15 to 20 patients so treated, the great majority were reported during this period.

A great factor in the retardation of progress in this field of surgery has been the assumption on the part of the medical profession that the operative procedure carries with it an enormously prohibitive mortality. In the early days this assumption was probably correct and served to emblazon with glory the first successful resection performed by Torek in 1913. It is to eliminate this fear on the part of the profession that the experiences of surgeons in this field should be constantly brought to their attention by published reports.

Heretofore the diagnosis of carcinoma of the esophagus was tantamount to signing the patient's death warrant and the physician advised palliative measures consisting of gastrostomy, radiation therapy or both. Under these circumstances, the average span of life was approximately 6 months. The rare case lived for more than 1 year. Yet, in spite of this hopeless outlook, most radiologists have questioned the wisdom of subjecting such patients to operation and have considered a successful outcome in the nature of a surgical feat not inconsiderably mixed with a good portion of luck. Some years ago, this point of view probably possessed an element of truth but, I wish to emphasize that, in the light of recent experiences, it no longer holds water. The low operative mortality in the series of cases which I have already reported and the additional operations to be described cannot be considered in the nature of a surgical feat, but rather one dependent upon early diagnosis, careful pre-operative preparation, a sound operative procedure based on our present day conception of radical cancer surgery expertly

administered anesthesia, meticulous postoperative care, and the immediate treatment of complications as they arise. This calls for maximum effort on the part of a well-trained, closely knit organization of operating-room personnel, anesthetist, nurses, physician, and surgeon.

In 2 previous papers I reported 6 cases of patients with esophageal cancer who were treated surgically, stressing the importance of early diagnosis, the need of careful pre-operative preparation, the problem of anesthesia, and the details of the operative procedure. Now I should like to report 4 additional cases and take up the problem of carcinoma at the lower end of the esophagus, especially with respect to its operative management.

I wish again to emphasize the importance of early diagnosis and the need of regarding with great suspicion any change in the act of swallowing in a person past 35 or 40 years of age. This calls for immediate roentgenographic examination by a competent radiologist. There is need for haste in arriving at a diagnosis, because frequently these tumors grow rapidly and may quickly reach the inoperable stage and this diagnosis should be made before great weight loss has occurred. Any deviation from the normal in the roentgenogram demands esophagoscopy examination. No patient should be subjected to operation unless a biopsy has been performed and the tissue pronounced carcinoma.

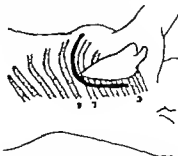


Fig. Incision is made in the seventh interspace, starting in the mid-clavicular line and carried posteriorly. It extends upward between the vertebral border of the scapula and the spinal column. The seventh, eighth, ninth, and tenth ribs are divided about an inch lateral to the transverse vertebral processes.

From the Surgical Service of Mt. Sinai Hospital.
Presented at the Cancer Symposium before the Clinical Congress of the American College of Surgeons, Philadelphia, October 6-10, 1939.

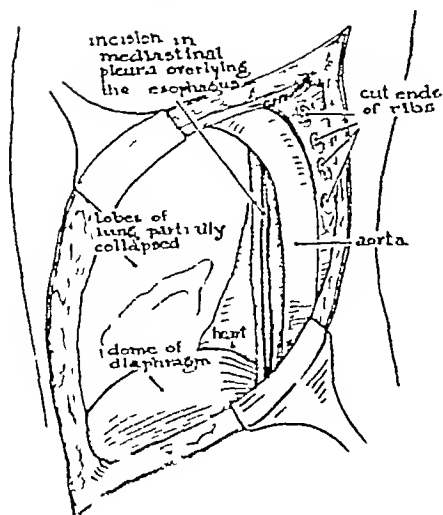


Fig 2

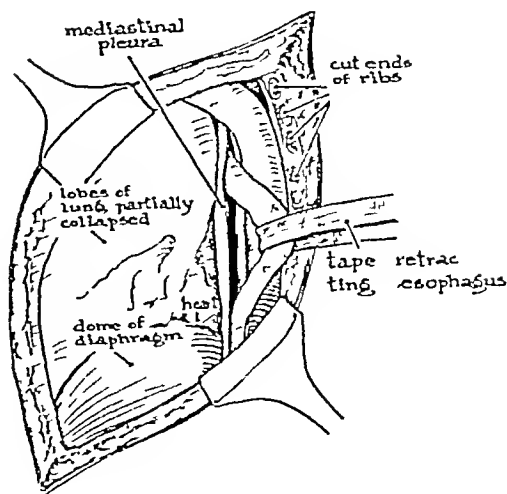


Fig 3

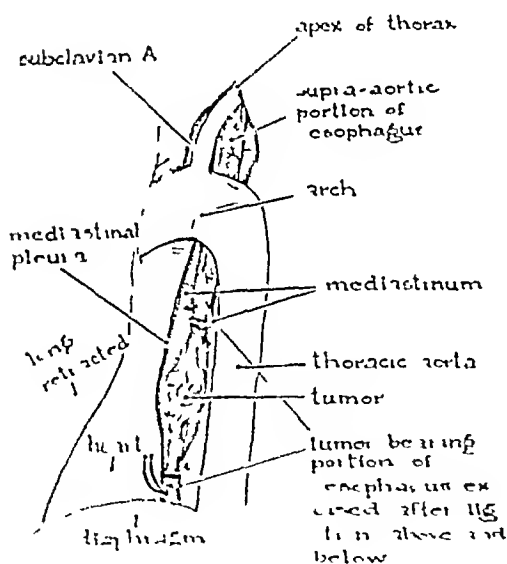


Fig 4

Fig 2. An incision is made in the infra aortic mediastinal pleura mesial to the aorta in order to expose the esophagus.

Fig 3. The esophagus is dissected from its attachment and a tape is placed about it. Traction on the tape aids considerably in freeing the organ.

Fig 4. The mediastinal pleura above the arch is incised and the esophagus is freed from the surrounding structures. The tumor bearing portion of the organ with a wide margin

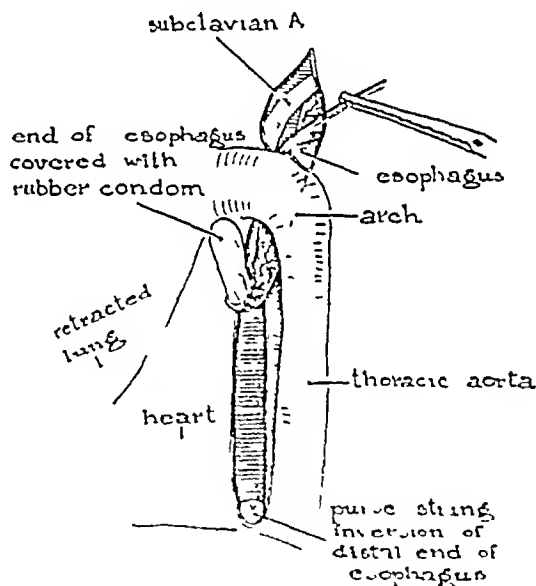


Fig 5

of normal tissue is removed after double ligation and division.

Fig 5. The divided end of the esophagus has been covered with a rubber condom which is sutured to the esophageal wall. The distal end of the esophagus is inverted into the stomach. The mediastinal pleura is not sutured. The infra aortic portion of the esophagus is brought to lie above the arch.

I have on previous occasions stressed the need for careful pre-operative preparation and indicated in detail what this involves. Suffice it to say that it should include a high caloric intake,

the administration of large quantities of fluid to overcome the dehydration which is frequently present, careful attention to mouth hygiene and transfusions. If the carcinoma is located in the

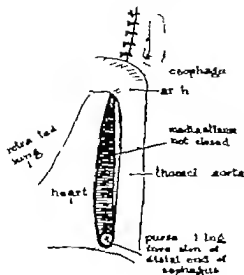


Fig. 6

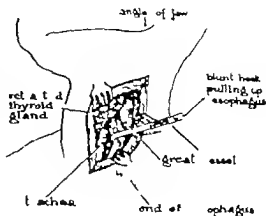


Fig. 7

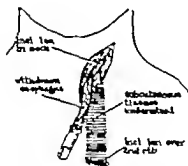


Fig. 8

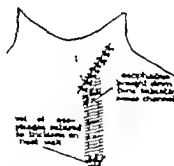


Fig. 9

Fig. 6. The mediastinum below the arch is left open to permit drainage of the cellular spaces. The pleura above the arch is sutured in order to close off the neck from the pleural cavity. The rubber-covered end of the esophagus has been pushed into the neck.

Fig. 7. Second stage of the operation. The cervical portion of the esophagus is exposed and the end of the organ covered by the rubber envelope, as indicated in the dotted lines, is drawn out of the wound.

Fig. 8. A subcutaneous channel is made, extending from the lower end of the cervical incision to about the region of the second rib.

Fig. 9. The esophagus is drawn through the channel so that its end projects beyond the skin incision for a distance of an inch. The incision is sutured to the wall of the esophagus with interrupted stitches of fine silk.

(Figures 5 to 9 reproduced through the courtesy of the New International Clinics Vol. 1 Series 1.)

proximal two-thirds of the organ, a preliminary permanent gastrostomy will be indicated. During the 7 to 10 days following the gastrostomy, considerable improvement may be noted. High caloric fluid food containing the necessary vitamins and minerals should be given frequently through the gastrostomy tube. Additional food should be taken by mouth in order to obtain the beneficial effects of the admixture of saliva.

If the carcinoma is located in the terminal 2 or 3 inches of the esophagus, preliminary gastro-

stomy should not be done, because in such cases, a stage operation is now advocated with re-establishment of continuity of esophagus and stomach by the performance of an intrathoracic esophagogastrostomy. The presence of gastrostomy would greatly complicate this procedure. I have been considering the performance of a preliminary jejunostomy for feeding purposes, but have not done so because I have felt that the upper abdominal adhesions caused by the jejunostomy might render the subsequent operation

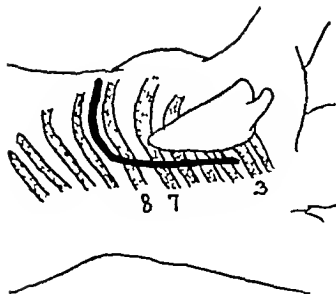


Fig 10

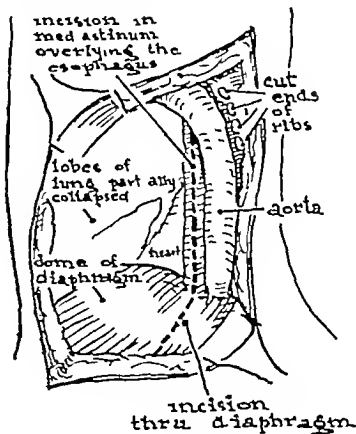


Fig 11

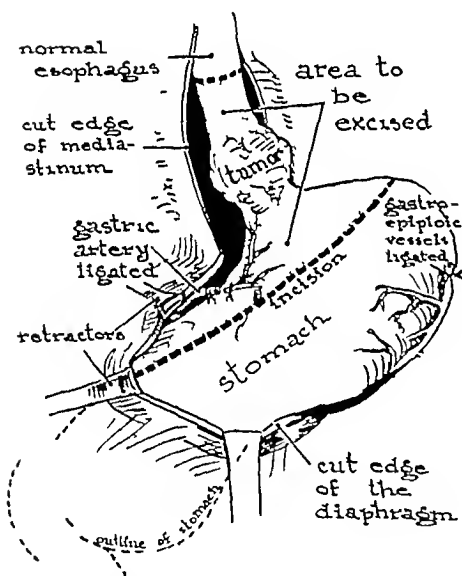


Fig 12

Fig 10 Operation of resection and esophagogastrostomy. Incision in eighth interspace. The eighth, seventh, sixth, and fifth ribs are divided near the transverse vertebral processes.

Fig 11 Incision made in mediastinal pleura. The diaphragm is split radially outward from the esophageal hiatus.

Fig 12 The tumor bearing portion of the esophagus

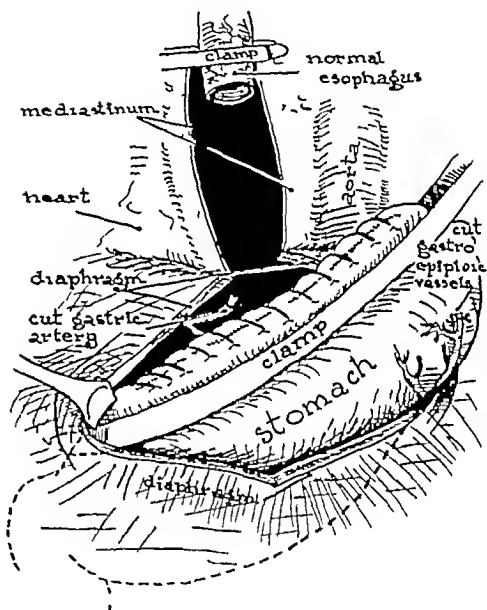


Fig 13

and the cardia have been separated from the mediastinum and the diaphragm. Mobilization of the stomach is accomplished by ligation and division of the gastric and left gastro-epiploic vessels.

Fig 13 The stomach is resected in an oblique direction well beyond the growth and is closed with 2 layers of silk sutures. The esophagus is transected well above the cancer. A small rubber-covered clamp prevents soiling.

more difficult. The smooth convalescence of the patients subjected to the 1 stage operation seems to justify this viewpoint.

Because the operation for esophageal cancer is performed by the transthoracic route, it has been stated by 1 or 2 writers that it is advisable to

establish pneumothorax on one or more occasions prior to operation in order to accustom the lung to the differences in pressure incident to the operative procedure. I have not seen the need for this up to the present time and have noted no complications which could have been obviated by

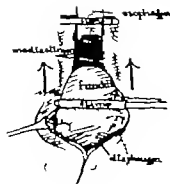


Fig. 4

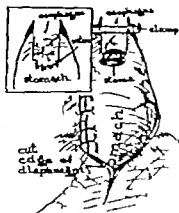


Fig. 5

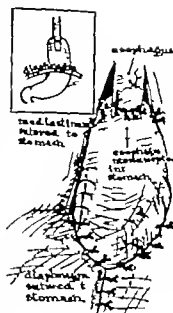


Fig. 6

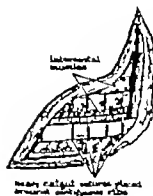


Fig. 7

Fig. 4. The stomach is drawn up and into the thoracic cavity and its upper end brought into position for anastomosis with the esophagus.

Fig. 5. An end-to-side anastomosis in layers is effected in the same manner as one performs gastro-enterostomy. Silk sutures are used. Care should be taken to avoid strangulation of thorax. Insert above the completed anastomosis.

Fig. 6. The esophagus is telescoped into the stomach by drawing the stomach up and in sleeve-like manner. To maintain this position, the stomach is tacked down to the esophagus and also to the mediastinal pleura with interrupted stitches of silk. The remainder of the mediastinum is left open. The opening in the diaphragm is partly closed, the remaining edges being sutured to the stomach wall in order to prevent herniation.

Fig. 7. The thoracic wound is closed by encircling the contiguous eighth and ninth ribs with heavy catgut sutures.

preliminary pneumothorax treatment. Reliance has been placed mainly on an expertly administered ethylene anesthesia, with varying degrees of positive pressure during the operation to vary the extent of lung inflation. The successful outcome of the operation is in no small measure dependent upon the skill of administration of the anesthetic agent.

OPERATION

For cancer located in the upper two-thirds of the thoracic esophagus radical resection by the modification of the original Torek procedure described in my last paper is the operation of choice. On the basis of considerable experimental and some clinical work it has been determined that it is impossible to resect a portion of the thoracic esophagus, perform an end-to-end anastomosis, and obtain satisfactory union and continuity of the viscous. The reasons for this are (1) In order

to effect a radical removal too large a section of the organ would necessarily be removed to permit bridging of the gap without great tension at the subsequent suture line. (2) The esophagus is devoid of colonic covering which is so important in satisfactory healing. (3) The longitudinal muscle fibers surrounding the esophagus exert so strong pull that any type of anastomosis is quickly torn apart.

This operation has been described in detail in previous publications. Figures 1 to 9 will indicate the essential steps. Briefly the procedure entails a left transthoracic approach, mobilization of the entire thoracic esophagus, resection of the tumor bearing portion with wide margin of normal organ on each side leaving the mediastinum open to drain its cellular tissues, closure of the chest wound with establishment of under water drainage mobilization of the cervical



Fig 18 Case 4 Roentgenogram of esophagus showing stenotic filling defect at the level of the arch of the aorta

esophagus through an oblique neck incision, and the establishment of an esophageal fistula at about the level of the left second rib anteriorly. Continuity of the organ is later established by artificial means in the form of a removable rubber tube which connects the esophageal fistula and the gastrostomy opening.

When the growth is located in the terminal 2 to 3 inches of the esophagus, every effort should be made to establish continuity of esophagus and stomach by a suture anastomosis. Sufficient evidence has been accumulated up to the present time to warrant the statement that the operation of intrathoracic esophagogastrostomy (end-to-side) is entirely feasible and is followed by solid healing with minimal diminution in the caliber of the lumen. I have, up to the present time, performed this operation 4 times, once for an esophageal cancer and 3 times for cancer at the cardiac end of the stomach. The latter group will form the basis for a subsequent paper. The autopsy specimen of one of the stomach cases shows solid healing at the site of anastomosis without stricture formation (Fig 29).

The operation, a modification of the original Sauerbruch and Fischer procedures, consists of a transthoracic approach, incision of the diaphragm, mobilization of the upper two-thirds of the



Fig 19 Case 4 Gross specimen showing complete encircling of esophagus by the neoplasm

stomach, resection of the tumor bearing area, the performance of a careful suture anastomosis between the end of the esophagus and the anterior wall of the stomach in 2 layers, and the telescoping of the esophagus into the stomach by drawing the latter organ upward in a sleeve-like manner around the esophagus in order to minimize any possible drag on the suture line.

The details of the operation are as follows. The patient is placed on his right side with the head resting on the abducted right arm and his back close to the edge of the operating table. The incision begins in the eighth interspace in the anterior axillary line and is curved posteriorly and ex-



Fig 20 Case 4 Photograph of patient 6 months after operation showing the rubber esophagus in place



Fig. 5. Case 5. Gross specimen showing marked stenosis and small submucous metastatic nodules.

tended upward between the spine and vertebral border of the scapula as far as the fourth rib (Fig. 10). The thoracic musculature is divided in the line of the skin incision. All bleeding points



Fig. 22. Case 6. Roentgenogram of esophagus and stomach showing the irregular defect at the lower end of the esophagus extending into the cardia.

are carefully ligated before the thoracic cavity is entered. An incision is made in the eighth inter space dividing the parietal pleura with the intercostal muscles. The eighth, seventh, sixth, and fifth ribs are quickly divided about 1 inch from the spine and the intercostal vessels are ligated with hemostatic sutures. Use of a rib spreader gives an excellent exposure of the left thoracic cavity. The inferior pulmonary ligament is divided which permits collapse of the lower lobe. Complete pulmonary collapse should not be permitted to take place. This can be controlled by the anesthetist.

The growth is now palpated. Intimate fixation to the aorta or vertebral column renders the case inoperable. A vertical incision is made in the mediastinal pleura medial to the aorta from the arch down to the diaphragm (Fig. 11). The esophagus is identified and freed bluntly from the mediastinal tissues. It is important to ligate the small esophageal vessels, but care should be taken not to jeopardize the blood supply of the esophageal stump to be utilized for the anastomosis. Fixation to the right mediastinal pleura should not deter the surgeon. I have encountered this complication on 3 occasions and have in each instance excised a portion of the right pleura in order to effect a radical removal. The defect may be closed quite easily by utilizing the stomach wall after it has been mobilized.

An incision is then made in the left leaf of the diaphragm, extending from the esophageal hiatus radially outward toward the ribs for a distance of 6 or 7 inches (Fig. 11). The esophagocardiac junction is freed bluntly from its loose attachment to the diaphragm. The spleen and fundus

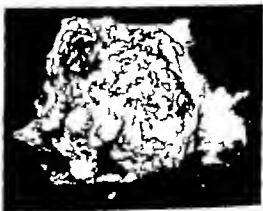


Fig. 3. Case 6. Gross specimen showing large cellular thickened neoplasm. There are no enlarged lymph nodes.



Fig 24



Fig 25

Fig 24 Case 6 Photograph of patient taken 30 days after operation

Fig 25 Case 6 Rear view of patient 30 days after operation, showing the well healed wound and the thoracotomy scar

of the stomach quickly appear in the wound. Judicious retraction of the edges of the diaphragmatic opening and the insertion of gauze packs will expose adequately the proximal half of the stomach. The left gastro-epiploic vessels are ligated and divided which permits the surgeon to enter the lesser sac. By inserting the left hand in the lesser sac and drawing the stomach downward, it is not difficult to isolate the gastric artery near its origin and to divide it after careful double ligation. Complete mobilization of the proximal half of the stomach is obtained following division of its ligamentous attachments at the upper part of the greater curvature. The stomach may now be drawn up into the thoracic cavity with ease (Fig 12).

During the resection of the growth and the subsequent anastomosis the entire chest cavity and wound must be protected from contamination. I regard the details of this part of the operation of great importance. Long rubber covered clamps are placed on the stomach side beyond the growth in an oblique direction from the upper greater curvature toward the lesser curvature and the stomach is divided with the carbolic acid cautery. The opening in the stomach is closed in 2 layers with silk, and care should be taken to ligate separately all bleeding points (Fig 13). A small rubber covered non-crushing clamp is now placed over the esophagus well above the tumor. A second crushing clamp is placed about $\frac{3}{4}$ of an inch beyond this and the esophagus is divided so as to leave at least $\frac{1}{2}$ inch of the organ projecting beyond the rubber covered clamp. The specimen is removed.

The upper end of the stomach in the region of the greater curvature is brought in approximation to the esophageal stump (Fig 14). A 2 layer suture anastomosis, end-to-side, is now performed between the end of the esophagus and the anterior wall of the stomach at a point about 2 inches



Fig 26 Case 6 Roentgenogram of esophagus and stomach taken 28 days after operation, showing the intra thoracic position of the stomach and the adequate new stoma between esophagus and stomach

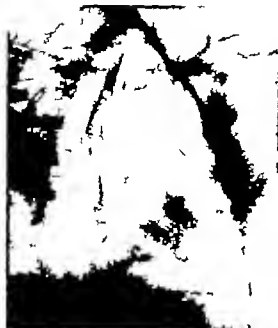


Fig. 27. Case 7. Roentgenogram of esophagus indicating an obstructing lesion at the level of the aortic arch.

beyond its upper end (Fig. 15). The inner layer is a continuous Connell suture of fine silk uniting mucosa and submucosa. Every stitch must be correctly placed. It is important to avoid strangulation of the tissues. The second layer is a continuous Lambert suture of fine silk, joining muscularis of esophagus to the muscle and peritoneal layers of the stomach. In order to protect the suture line from longitudinal tension, the stomach is drawn upwards like a sleeve over the suture line and is anchored in this position by interrupted sutures of fine silk which include the muscularis of esophagus and the cut edges of the mediastinal pleura (Fig. 16). The new anastomosis will usually be situated an inch or two below the arch of the aorta and it will be seen that approximately one half of the stomach now occupies an intrathoracic position.

The radial incision in the diaphragm is now closed with interrupted sutures of silk; care is taken not to make the opening through which the stomach emerges too small. To prevent herniation of more stomach into the chest, the edges of the diaphragmatic opening are sutured to the stomach wall (Fig. 16).

Through a small stab wound in the subjacent intercostal space, soft rubber tube is inserted for under water drainage. The thoracic wound is

repaired in the usual manner by encircling the contiguous eighth and seventh ribs by heavy chromic sutures (Fig. 17). The chest musculature is carefully repaired layer by layer and the skin is closed with silk. The anesthetist inflates the lungs, thus helping the escape of air in the pleural cavity through the intercostal drainage tube the end of which has been placed under water. A snug dressing is applied so as to support the severed ribs.

Every patient reported in this series of cases has received a transfusion of 500 cubic centimeters of blood during the course of the operation. It has been both surprising and gratifying to see these patients go through this extensive procedure with little evidence of shock. The pulse has varied between 80 and 128. The blood pressure readings have shown very little variation; a slight drop occurred during ligation of the gastric artery and mobilization of the stomach. I believe that it is important to emphasize the fact that the various steps of this operation must be carried out with great gentleness and with minimal trauma to the lung parenchyma.

POSTOPERATIVE CARE

Before this operation is undertaken it is very important to explain to the patient that he must not swallow for a period of 5 or 6 days. The processes of repair at the suture line will be hastened by the full co-operation of the patient in this respect. To supply fluids, use is made of the con-



Fig. 28. Case 7. Gross specimen of resected esophagus showing large punched-out ulceration with firm overhanging edges and necrotic base. The gross, this similar to the epitheliomas of the lips, tongue and skin.

tinuous intravenous drip of 5 per cent glucose in normal saline. It may be necessary to give another transfusion during the first day or two. I have placed the last 3 patients in an oxygen tent immediately following the operation. It is my impression that these patients have had much less difficulty with breathing, and it may be a factor in the prevention of postoperative pneumonia. It is important to administer sufficient morphine to keep the patient quiet and comfortable.

I have been considering the idea of passing a Levin tube at the time of operation beyond the suture line into the stomach for feeding purposes. However, Bohrer's recent experience with a case in which this was done strengthened my belief that it would not be without danger. The situation at the suture line is precarious enough without adding the danger of pressure necrosis from a Levin tube.

The character of the material draining through the intercostal tube will indicate the progress of the intrathoracic situation. During the initial 24 to 36 hours the fluid is frankly bloody. After this it gradually assumes a lighter color and decreases in amount until about the seventh or eighth day when it usually stops completely. The tube may be removed about the tenth day.

Small sips of water may be given on the fifth or sixth day. If nothing appears through the drainage tube, it is assumed that the suture line has healed and is intact. Increasing amounts of liquid are now given until about the sixteenth day when custards, gelatins, cereals, etc., are permitted. The diet is rapidly increased thereafter. Solid food should not be given until the third or fourth week. In none of the patients has there been any indication of stricture formation at the site of anastomosis.

RESULTS

Up to the present writing I have operated upon 10 patients with carcinoma of the thoracic esophagus. Three, who were previously reported, were found inoperable, making an operability percentage of 70. Of the 7 remaining patients, 6 survived the radical operation, making the mortality rate 14.2 per cent. Follow-up observations of the first 3 patients were published recently, but I wish to repeat them briefly at this time.

Case 1 died of a recurrent tumor in the superior mediastinum 22 months after operation. Case 2 is alive and well 2 years and 11 months after the radical resection. Case 3 died 3 months after operation of coronary artery disease. At autopsy no remaining evidence of cancer was found.

The 4 remaining cases are being reported now for the first time. The patient in Case 4 is alive 1 year after oper-

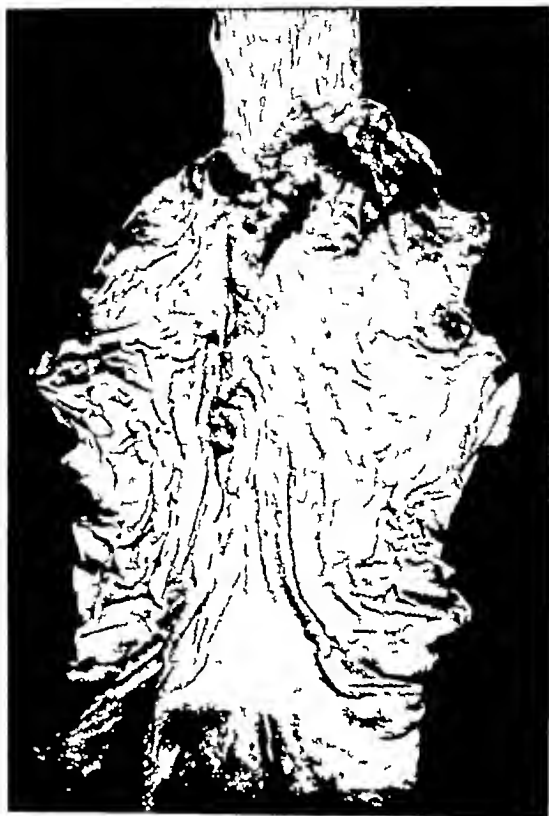


Fig 29 Postmortem specimen. This patient had a resection and transthoracic esophagogastrostomy performed for carcinoma of the cardia. He died of a cerebral embolus on the fourth day. The suture line is intact and healing has progressed sufficiently to render the new stoma water tight. The telescoping of the esophagus into the stomach may be seen at the right corner of the anastomosis. This case will be reported at a later date.

ation. The patient in Case 5 succumbed to operation. In Case 6, patient had a resection with intrathoracic esophagogastrostomy, and is alive and well 8 months after operation. The patient in Case 7 was operated upon recently and is doing well.

We may summarize our results as follows. Of 7 patients subjected to radical resection, 6 survived the operation. Of these 6 patients, 4 are alive and well.

In addition to these 7 cases of primary carcinoma of the esophagus, I have performed radical resection and intrathoracic esophagogastrostomy in 3 instances of carcinoma originating at the cardia and secondarily involving the lower esophagus. These cases will form the basis of a subsequent publication. Suffice it to say at this time that, from this experience, I am convinced that the only logical method of treating cancer in this

situation is by the transthoracic transdiaphragmatic route detailed in this paper. It is my belief that none of the other described methods are based on the sound surgical principles of adequate exposure, free vision of the operative field, mobilization of the involved viscera, preservation of the blood supply of the remaining segments, radical excision of the cancer bearing focus with all lymphatic tributaries, and physiological restoration of esophagogastric continuity by a layer suture anastomosis.

CASE REPORTS

CASE 4. J. S. man aged 46 years, as admitted to Mt. Sinai Hospital on October 1, 1935. He complained of difficulty in swallowing of 7 months' duration. I question the accuracy of this statement. If the carcinoma existed for 7 months, it could have been beyond the operable stage. At least, such has been our experience. The patient had lost only 3 pounds. When admitted to the hospital, he was able to swallow only liquids.

Examination showed moderately emaciated white male with no abnormal findings except for few discrete, small, lymph nodes palpable in the left anterior and posterior cervical regions.

Laboratory examinations were all negative. Hemoglobin, 88 per cent, uric acid, negative. Roentgenographic examination of the esophagus revealed partially obstructing lesion in its upper third at the level of the arch of the aorta (Fig. 8). Esophagoscopy disclosed an infiltrating new growth on the anterolateral wall about 30 centimeters from the upper incisor teeth. The biopsy specimen revealed squamous cell carcinoma.

On October 6, 1935, James's gastrostomy as performed under local anesthesia. Feeding was commenced on the first postoperative day. The wound healed *per primam*.

On October 20, 1935, resection of the esophagus as performed under verteb, atropine anesthesia. The technique described in the text as employed. The growth as located between the arch of the aorta and the left main bronchus. It was rather firmly attached to the bronchus. In our experience this location is particularly bad one, because fixation to the bronchus takes place early and complete excision of the cancer may not be possible. I would hazardly guess that the recurrence rate is eventually be found highest in those cases in which the original tumor is located at this site.

Considerable difficulty was encountered in separating the tumor from the bronchus. This was finally accomplished without sacrificing any important structures. The esophagus was divided just above the cardia and the distal end as inverted into the stomach with purse string suture of silk. The remainder of the organ was freed as far as the root of the neck and pushed into the neck above the superior mediastinal plane. The latter structure was now repaired. The intra-aortic mediastinum was left wide open. The chest wound was closed, with the establishment of under water drainage through an intercostal tube. The cervical portion of the operation was completed with the formation of an esophageal fistula opposite the left first rib.

The patient's pulse during the operation, which consumed 4 hours and 5 minutes, varied between 84 and 66. The breathing was regular. A transfusion of 500 cubic centimeters was given during the operation and followed

by continuous intra-ear drip of 5 per cent glucose in saline.

Examination of the specimen (Fig. 9) disclosed an infiltrating squamous cell carcinoma. The small metastatic lymphatic nodules near the growth. It was found that the carcinoma had infiltrated the entire esophageal wall.

After the operation the patient was placed in an oxygen tent. Here he remained for 7 days. During the first 24 hours the pulse varied between 94 and 83, and the temperature between 99 and 101.6 degrees F. The drainage through the intercostal tube rapidly diminished in quantity and finally ceased on the eighth day. The tube was removed 4 days later. The patient began to swallow liquids through the esophageal fistula on the second day. By the second week, the temperature had reached normal and the patient was allowed out of bed. The thoracic and cervical wounds had healed *per primam*.

Because of the location of the growth and the uncertainty of its complete removal, intense radiation therapy was started during the third week. During the fifth week the temperature began to rise and reached 104 degrees F. For the next 2 weeks the fever assumed septic course, ranging between 100 and 105 degrees F. Repeated roentgenographic and laboratory examinations gave no clue as to the cause of the fever. For some unexplained reason the temperature finally reached normal and remained so until the patient was discharged.

During the eighth week the patient complained of severe precordial pain radiating down the left arm. Examination of the heart revealed nothing of note. However, the electrocardiogram suggested recent myocardial damage by means of more deeply inverted T and T₃ with compensatory. The cardiologist interpreted these findings as due either to actual myocardial infarction or to inflammatory myocarditis. For this reason the patient was kept in bed for months.

The rubber esophagus was inserted during the third week and from that time the patient took most of his food by mouth. He was discharged 4 months after operation and had gained 8 pounds (Fig. 10).

The patient was carefully followed after discharge. He remained well until the latter part of July, 1936, and reached his normal weight of 145 pounds. When seen 1 year after, he called attention to firm swelling located at the orifice of the esophageal fistula. This measured 1/4 inch in diameter, was discrete and firm, and seemed to be located in the anterior wall of the esophagus. A biopsy specimen revealed the features of squamous cell carcinoma similar to the original growth. Intensive radiation therapy was instituted. After 6 weeks the lump was no longer palpable. Recently the patient entered the hospital complaining of hoarseness and loss of 10 pounds in weight. Examination disclosed right Horner's syndrome and paralysis of the right vocal cord. Chest roentgenograms have been repeatedly negative. However, it is apparent that there is recurrence in the superior mediastinum.

CASE 5. E. P. man of 60 years, referred by Dr. Frank J. McGowan, as admitted to the New York Hospital on March 9, 1935. He complained of dysphagia of 10 years' duration. This was accompanied by increasingly severe substernal oppression. The dysphagia became more pronounced until, at the time of admission, he was able to swallow only liquids. He had lost 30 pounds.

The personal history revealed that the patient had been a fireman for over 30 years and had been overcome by smoke on many occasions. Otherwise he had always been in robust health.

Physical examination revealed a very well developed muscular individual, apparently in excellent health. There

were no abnormal findings. The heart and lungs were negative and there was no shock tenderness over the thoracic spine. Blood pressure systolic, 136, diastolic, 74.

Laboratory examinations were all normal. Roentgenogram of the esophagus showed an obstruction, almost complete, starting about an inch below the aortic arch. Esophagoscopy revealed an obstructing, ulcerated neoplasm located about 34 centimeters from the upper incisor teeth. The biopsy specimen indicated a hornifying squamous cell carcinoma.

On March 14, 1939, a Janeway gastrostomy was performed under local anesthesia. Feedings were started on the next day. The operative wound healed by first intention. There was a weight gain of 3 pounds during the succeeding 12 days.

On March 22, 1939, resection of the esophagus was performed under avertin, ethylene anesthesia. The technique described in the text was employed. The neoplasm was about 2 inches in length and was situated just below the arch of the aorta. It was found to be intimately attached to the right mediastinal pleura. In order to effect removal it was necessary to excise a fairly large portion of the right pleura, thus producing a bilateral pneumothorax. The opening was temporarily packed with gauze. The esophagus was divided above the cardia and the distal end was doubly inverted into the stomach. The organ was then completely freed from its attachments and pushed into the base of the neck after the supra aortic mediastinal pleura was incised. The latter was then repaired so as to close off the neck from the thoracic cavity. In order to close the opening effectively in the right mediastinal pleura, it was found necessary to suture the left mediastinal pleura. A stab thoracotomy in a subjacent intercostal space completed the thoracic phase of the operation.

The cervical part of the operation was then completed in the usual manner. An esophageal fistula was fashioned over the left second rib anteriorly.

During the operation, which consumed 2 hours and 50 minutes, the pulse varied between 82 and 116 and the systolic pressure between 130 and 110. A transfusion of 500 cubic centimeters was given during the procedure and the patient left the operating table in excellent condition.

The specimen (Fig. 21) consists of a segment of esophagus, measuring 12 centimeters in length and 6.5 centimeters in average circumference. At its mid point it is narrowed to approximately 2.5 centimeters by a thick, infiltrating tumor which invades the wall. The tumor has an ulcerated surface, the ulcer is linear rather than circular, which gives it a longitudinally excoriated appearance. Two centimeters proximal to this is a nodular whitish mass 15 by 10 millimeters in area, the center of which is also excoriated. The mucosa over this tumor is apparently well preserved. Beneath it is a white tumor mass which extends through the wall. There is no apparent lymphoid connection between the 2 tumors. The mucosa on the opposite side of the main growth shows numerous linear rows of whitish tubercles approximately 1 millimeter in diameter. The outer side of the specimen shows a complete covering of musculature, which on section, in the region of the growth, reveals invasion by tumor tissue. The substance of the tumor and that of the overlying mucosa is very friable. Microscopic examination reveals the features of an epidermoid carcinoma with numerous mitotic figures. The tumor extends through the entire esophageal wall. Sections taken through the smaller growths reveal carcinoma also with tumor cells in the lymphatics.

In the light of subsequent events, a serious error of omission was committed. The right chest should have been aspirated at the completion of the operation to remove the large amount of air trapped in the right pleural cavity.

I believe that, if this had been done, the patient would have survived.

On the following day serious respiratory embarrassment developed. The patient was wildly delirious and required large doses of sedative. Only slight improvement was noted after he was placed in an oxygen tent. Physical signs of a complete right pneumothorax were apparent. On chest aspiration, approximately 7,000 cubic centimeters of air was removed. A stab thoracotomy was performed with under water drainage. The patient seemed to improve for a few hours. However, soon after, he rapidly became comatose and died 40 hours after operation with a terminal temperature of 107.6 degrees F.

Postmortem examination revealed a tension pneumothorax on the right side with atelectasis of the entire right lung. The operative field was clean and the sutured left mediastinal pleura effectively separated the left from the right pleural cavity. In one tracheobronchial lymph node a small metastasis was noted.

CASE 6 J. C., a white male of 60 years, was admitted to the surgical service of Mt. Sinai Hospital on April 19, 1939. His main complaint was difficulty in swallowing food, of 5 weeks' duration. The onset was quite sudden with dysphagia accompanied by aching pain behind the lower end of the sternum. During the succeeding 5 weeks the dysphagia and pain became more pronounced. At the time of admission he had difficulty in swallowing even liquids. There was a weight loss of 12 pounds.

His past history was negative except for excision of a left varicocele 35 years before. He stated that he had been rejected for life insurance 20 years ago because of "heart disease."

Physical examination disclosed a moderately well developed elderly white man with evidence of recent weight loss. There was slight tenderness on firm pressure over the lower end of the sternum adjacent to the fourth costal cartilage. The heart and lungs were negative. Blood pressure systolic, 130, diastolic, 75.

Laboratory examinations revealed hemoglobin 59 per cent, urine negative. Blood urea 21 milligrams per 100 cubic centimeters, blood sugar, 70 milligrams, Wassermann, negative. Roentgenogram of the esophagus following the ingestion of barium mixture showed the presence of an obstructing lesion just above the cardiac end of the stomach. The neoplasm extended through the cardia for a short distance (Fig. 22). Esophagoscopy revealed a crater like circular ulcerating neoplasm in the distal esophagus 39 centimeters from the upper incisor teeth. The biopsy specimen showed an infiltrating hornifying squamous cell carcinoma.

The preliminary preparation consisted of a transfusion of 500 cubic centimeters of blood, high caloric feedings, and the administration of sulfanilamide for 3 days before operation.

Operation was performed on April 27, 1939. The technique described in the text was followed. The incision was located in the eighth interspace and the seventh, sixth, and fifth ribs were divided near the spine. The neoplasm was felt in the lower end of the esophagus and involved the distal 2 inches of the organ. It extended through the diaphragm into the cardia for a short distance. It was densely adherent to the diaphragm at the esophageal hiatus. In order to obtain definite information concerning operability, a radial incision was made in the diaphragm from the esophageal hiatus outward. There were no palpable lymph nodes in the gastrohepatic omentum or in the mediastinum. Aside from the firm attachment to the diaphragm, the tumor was considered operable. A radical removal was affected by excising a portion of the diaphragm with the tumor. The stomach was mobilized by ligating

and dividing the gastric artery and the left gastric epiploic vessels. The esophagus as freed from its surrounding attachments as far as the arch of the aorta, and end-to-side anastomosis as performed between the stump of the esophagus and the anterior wall of the stomach near the greater curvature still as used for both layers. The stomach as pulled up and over the suture line in sleeve-like manner and anchored with interrupted stitches to the esophageal wall and to the cut edges of the mediastinal pleura in this situation.

In dissecting the tumor from the diaphragm and the lower mediastinum it was found necessary to excise small section of the right mediastinal pleura, thus producing bilateral pneumothorax. This opening as closed by suturing the stomach wall to the edges of the right pleural opening.

The diaphragm was now closed to each side as to prevent constriction of the transposed stomach. To prevent herniation of the stomach into the chest, the edge of the diaphragmatic opening was sutured to the stomach wall. A stab wound thoracostomy for under water tube drainage was made in the subject lateral costal space. At the completion of the operation the right chest as aspirated and 3,000 cubic centimeters of air was removed.

The patient showed very little evidence of shock during this procedure, which consumed $\frac{1}{2}$ hours. The pulse varied between 80 and 90, blood pressure between 90 and 100. A transfusion of 900 cubic centimeters of blood as given during the course of the operation. This as followed by continuous intravenous drip of 5 per cent glucose and saline.

Examination of the specimen showed squamous cell carcinoma of the esophagus showing the curbs of the stomach. No enlarged lymph nodes are found (Fig. 3).

After operation the patient as placed immediately in an oxygen tent here he remained for 4 days. He did not swallow for 6 days. In addition to the enteric tube drip, concentrated vitamin extracts are administered parenterally. On the first postoperative day the pulse varied between 90 and 100. Temperature as 100.8 degrees F. For the first 6 days the temperature ranged between 99 and 100.4 degrees F. His pulse ranged between 90 and 100. His general condition was excellent. He developed mild cough. His expectoration of small amounts of mucopurulent material. The drainage from the thoracostomy tube, as first bloody rapidly diminished and finally stopped on the eighth day. The tube was removed on the ninth day. The operative wound healed by primary union. The hemoglobin fell to 55 per cent on the sixth day. It was given several blood transfusions after which the hemoglobin rose to 80 per cent. Small amounts of sputum are swallowed for the first time on the sixth day. There as no difficulty. On the sixth day signs of right pleural diffusion developed. Upon aspiration 1,500 cubic centimeters of thin, serous-purulent fluid was withdrawn. There was no re-accumulation. The patient's course, therefore, as uncomplicated. His food intake by mouth as rapidly increased in quantity and quality. On the twenty-third postoperative day barium was given by mouth and roentgenograms of the esophagus and stomach are obtained (Fig. 6). The patient gained eight steadily and had no difficulty in swallowing. He was discharged from the hospital on the thirty-fifth postoperative day in excellent condition (Figs. 24 and 25).

Since discharge from the hospital, the patient has done well. He eats everything but finds that he must masticate his food thoroughly. He has returned to his normal weight.

CASE 7. M. G. male, of 35 years, was admitted to Mt. Sinai Hospital on August 10, 1930. This is the youngest patient with carcinoma of the esophagus that have encountered in our experience. He complained of dysphagia

of 4 weeks' duration. In addition, he stated that approximately 3 months before he began to be pale in the anterior chest region and also in the middle of the back. The difficulty in swallowing became progressively worse until the time of admission he as able to swallow only liquids. He had lost 35 pounds.

His past history as completely negative. His blood always been all and had not undergone any operations.

Physical examination disclosed all developed and rather all nourished young man as appeared to be in good health. There as no obvious anemia. The heart and lungs are negative. There as no shock tenderness over the thoracic apophysis.

Laboratory examinations revealed the urine to be negative—hemoglobin, 93 per cent red blood cells, 5,000,000, normal but blood cell count Wassermann, negative. Roentgenographic examination of the esophagus disclosed an obstruction beginning just behind the arch of the aorta and extending downward for a distance of approximately 10 inches (Fig. 27). Esophagoscopy showed an ulcerated neoplasia situated on the posterior wall of the esophagus about 30 centimeters from the upper incisor teeth. The biopsy examination revealed squamous cell carcinoma.

On August 19, 1930, January gastrectomy as performed under local anesthesia. Tube feedings are started the next day. Operation wound healed by first intention. On August 2, radical resection of the esophagus as performed under avertin, ethylene anesthesia. The neoplasia as located between the arch of the aorta and the left main bronchus. It as easily separated from the aorta, but was densely adherent to the bronchus. The entire esophagus as freed and the tumor bearing portion as separated from the surface of the bronchus by sharp dissection. There as some doubt to the operator's mind concerning the complete extirpation of the tumor because of this firm attachment. The esophagus was divided at its lower end and the distal end simply is inserted into the stomach. Its suture. The remainder of the esophagus as pushed up into the base of the neck after an incision as made in the superior aortic mediastinal pleura. The latter structure as now repaired. Its interrupted silk stitches in order to close off the pleural cavity from the neck. The mediastinum as left side open. A stab thoracostomy as made in the subject lateral costal space for under water tube drainage. The cervical part of the operation as now completed with the establishment of an esophageal fistula opposite the second left rib.

During the course of the operation, which consumed hours and 50 minutes, the patient's pulse varied between 80 and 90. The blood pressure dropped from 90 to 80 during the dissection of the growth from the arch of the aorta. A transfusion of 900 cubic centimeters of blood as given during the operation and as followed by continuous intravenous drip of 5 per cent glucose in saline. The patient left the operating table in excellent condition.

The specimen (Fig. 8) consists of resected segment of esophagus which measures 8 centimeters in length and 4 centimeters in width. Beginning about 1 centimeter from one end is an oval shaped tumor mass which is retroflexed pleurated in the central portion. This measures 4.5 centimeters in length and 2 centimeters in width. The edges of this ulcerated tumor are distinctly elevated and firm, and the mucosa covering the edges cannot be moved against the underlying structure. The ulcer base is grayish yellow in color and appears to be quite cellular. The ulcer undermines the edges to considerable depth in several areas. The remaining mucosa is grayish, glistening, and grossly not normal. No lymph nodes can be seen. The macroscopic picture is that of an infiltrating, hardening squamous cell carcinoma.

During the initial 24 hours the patient's general condition remained excellent. On the second day the temperature rose to 104 degrees F with a pulse rate of 130. The drainage from the intercostal tube was bloody. On the third day the fever reached a lower level, but the respiratory rate rose to 40. Signs of consolidation were elicited over the right lower lobe. The patient was placed in an oxygen tent and sulfapyridine was administered by gastrostomy tube. During the next 36 hours the temperature fell to normal and the patient's general condition was quite satisfactory.

On the seventh day mild respiratory difficulty was noted and the temperature rose to 103.8 degrees F. A bedside roentgenogram of the chest suggested fluid at the left base. There was a leucocytosis of 21,000. The intercostal tube was draining a small quantity of thick serous fluid. Chest aspiration posteriorly and laterally gave negative results. On the tenth day a slight respiratory bulge was noted in the center of the thoracic incision which had healed *per primam*. A probe was inserted at this point and entered a collection of 14 ounces of bloody fluid located in a walled-off portion of the pleural cavity in the vertebral gutter. The opening was enlarged and tube drainage instituted.

Following the evacuation of this fluid, the patient's condition improved rapidly. The temperature fell gradually and the respiratory rate reached normal. The rubber esophagus was inserted on the thirteenth day and all feedings were taken by mouth thereafter.

At the present writing, it is 16 days since operation. The patient's condition is improving rapidly and it is expected that he will be allowed out of bed within the next few days.

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SURVIVAL STATISTICS OF BREAST CANCER

1925 to 1935

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IT has long been felt that within recent years certain advancements in clinical and laboratory technique, in surgery, in roentgenography and in radium therapy warranted the assumption that survivorship percentages of patients treated by these methods would be improved substantially.

The education of the public to the importance of the early diagnosis in malignant diseases as stressed by the American Society for the Control of Cancer emphasized by the American College of Surgeons, and made possible through the establishment of tumor clinics such as at Jefferson Hospital in 1930, where collective diagnosis by a trained staff becomes a reality should also support this conclusion.

This survey was conceived for the purpose of determining whether the anticipated results could be substantiated by an analysis of actual records of a general hospital with this exception—the equipment and staff of Jefferson are those of a teaching institution and for the previously discussed reasons this 10 year period from January 1, 1925 to December 31, 1934 was selected.

For comparison this 10 year period was divided into two 5 year periods in the first period that of 1925 to 1929 there were 167 cases, and in the second period, 1930 to 1934, there were 266 or a total of 433. Of these 433 cases, 6 patients died from other causes, which left a total of 427. The survivorship percentage at the end of the fifth year for the 1925 to 1929 cases was 39.75 and for the 1930 to 1934 cases it was 34.80 per cent. At the end of 9 years, the survivorship percentage for the 1925 to 1929 cases was 2 per cent as against 16 per cent for the 1930 to 1934 group.

While in this report only cancer of the breast is being presented, the survey eventually will include all types and all sites of cancer both ward and private—young and old, early and advanced.

This report has already revealed to us that the only method with which to evaluate the results

of all cancer therapy is through a complete history of the case at the time of treatment and a follow-up service thereafter as long as the patient is alive.

The follow-up services have always been difficult and expensive due to a constant shifting among the city and suburban population. These cases were followed up through the family physician and specialist who were first consulted, the Social Service Department of the hospital, and finally by the Retail Credit Company of Atlanta, Georgia. The latter was most successful in tracing cases in distant parts of the United States, Canada, South America, and Europe.

Recognizing the complexity of this kind of statistical survey we consulted Dr. Raymond Pearl, director of the Department of Biology, School of Hygiene and Public Health of Johns Hopkins University and his associates, Dr. Antonio Clerico, Dr. B. Ashery Schneider and Joseph F. Kish who were given the responsibility for the construction of the survivorship graphs and charts which are being presented here.

In evaluating these charts the adjustment for the age factor is taken from the U. S. Life Tables of 1930 (white females in the continental U. S.) for the 1930 to 1934 group and for the 1925 to 1929 group the life expectancy values were obtained by interpolating between the 1920 and the

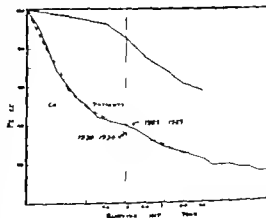


Chart U. S. general population 1930 life table (female)

From the Department of Neoplastic Diseases, Flushing Mark Kraemer Memorial and sponsored by Parke and Lamont du Pont, Jefferson Medical College Hospital. Presented at the Cancer Symposium before the 10th Congress of the American College of Surgeons, Philadelphia, October 6-10, 1930.

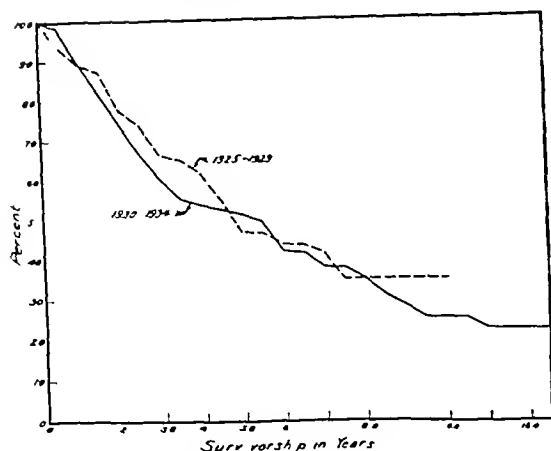


Chart 2 No metastases

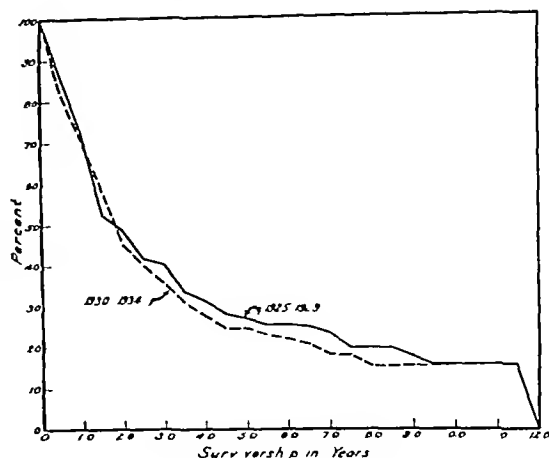


Chart 3 Metastases

1930 life tables The manner of calculation was as follows

Age in years	Life expectancy per 100,000
30 to 31	87,972
31 to 32	87,644
32 to 33	87,308
33 to 34	86,964
34 to 35	86,611

This means that of 100,000 white females born alive, 87,972 are expected to survive to exactly 30 years of age, 87,644 thirty-first year, etc. Thus, a white female, 30 years of age, when nothing is known about the condition of her health, has a $87,644/87,972$ probability of surviving exactly 1 year, a $87,308/87,972$ of surviving exactly 2 years, etc. In a similar manner, the probabilities for each of the 417 cancer of the breast patients for surviving 1 year, 2 years, up to and including 13 years were calculated. For example, there are 57 cases in the "no metastasis, with operation and x-ray" division of the 1930 to 1934 group, for which the actual age and survival is known. Now a survivorship curve for 57 white females having the identical age distribution of each of the 57 cancerous patients is plotted, based on their probability of surviving exactly 1 year, 2 years, 3 years, etc. The percentage deviation of

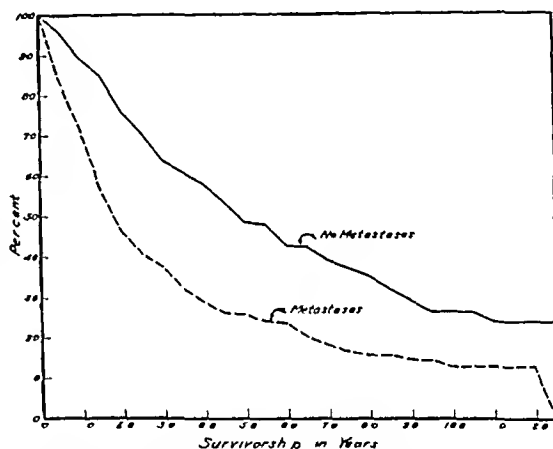


Chart 4. Combined data on patients with and without metastases for 1925 to 1929 and 1930 to 1934

the actual observed survivorships of the 57 cancerous females at each year from this "expected" survivorship is then plotted

When a curve coincides with the 0 per cent line or curve as in Chart 1, it means that that group is dying off at the same rate as a group of the same age composition selected from the general population of white females. Coincidence with the

TABLE I—TOTAL DATA FOR SURVIVORSHIP

Survey grouping	Total number of cases	Total number living at end of 5th year	Per cent of total number living end of 5th year	Dead at end of 5th year	Per cent of deaths during 5th year	Deaths other than cancer	Survivorship per cent calculated (see example)
Normal	417	352	84.41	65	7.90		85.23
1925 to 29	166	65	39.15	100	7.04	1	39.75
1930 to 34	251	73	29.08	163	18.92	15	34.80

TABLE II—SURVIVORSHIP OF PATIENTS WITH OR WITHOUT METASTASIS

Survey grouping	Cases Total No.	Total number living at end of 5th year	Per cent of total number living	Deaths at end of 5th year	Per cent of deaths 1st-5th inclusive 5th year	Deaths other than cancer	Survivorship per cent according to group
1925 to 1929 Metastases		20	27.43	54	76		27.43
Non-metastases	74	30	39.00	37	44		39.00
1930 to 1934 Metastases	144	30	20	108			21.46
Non-metastases	304	30	20.47	35	14.84	8	20
1935 to 1939 Metastases	3	49	63.47	16	81		25.49
Non-metastases	12	80	53.57	93	91.7	9	53.57

100 per cent ordinate means that the group has died before the end of 1 year. The closer a curve approaches the 0 per cent line or curve, the more nearly the members of that group are dying off as one would expect a similar number of females of the same age composition from the general population to do.

In Table I, the total data for the survivorship for 1925 to 1929 and 1930 to 1934 groups compared with a normal U. S. Life Table group of the same age composition, appear from which Chart 5 is plotted.

To determine the survivorship per cent for any desired period, obtain from the appropriate table or curve the percentage of deaths during this period and subtract this value from 100, thus finding the per cent of persons who were alive at the start and close of this period. Then from the appropriate curve obtain the survivorship per cent for the beginning of the period under discussion, and multiply it by the per cent of persons who were alive at the start and close of this

desired period. For example to determine the survivorship per cent of the normal group in Table I for the five year period refer to Chart 5. From the observed values for the normal group, the percentage of expected deaths during the fifth year can be found by subtracting the percentage surviving at the end of the fifth year from the percentage surviving at the end of the fourth year, which is 7.90 per cent. Then subtract this figure (7.90) from 100 to obtain the per cent of all those who started the period alive and are still living at its conclusion. Then the percentage survivorship for the fifth year is obtained by multiplying the remainder just obtained (92.10) by the percentage surviving at

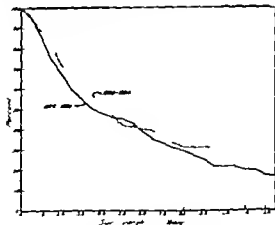


Chart 5. All patients operated upon.

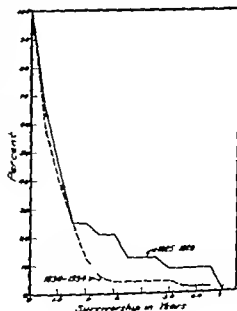


Chart 6. All patients not operated upon.

TABLE III.—SURVIVORSHIP DATA ON PATIENTS OPERATED AND NON-OPERATED UPON

Survey grouping	Cases Total No	Total number living at end of 5th year	Per cent of total number living	Deaths at end of 5th year	Per cent of deaths July Dec. inclusive 5th year	Deaths other than cancer	Survivorship per cent according to graph
1925 to 1929 Operation	142	63	44.36	78	1.54	1	45.68
Non-operation	24	2	8.33	22	53.33	0	8.33
1930 to 1934 Operation	200	71	35.50	114	8.09	15	42.78
Non-operation	47	2	4.25	45	0	0	4.26
1925 to 1934 Operation	342	134	39.18	192	5.85	16	43.77
Non-operation	71	4	5.63	67	20.00	0	5.63

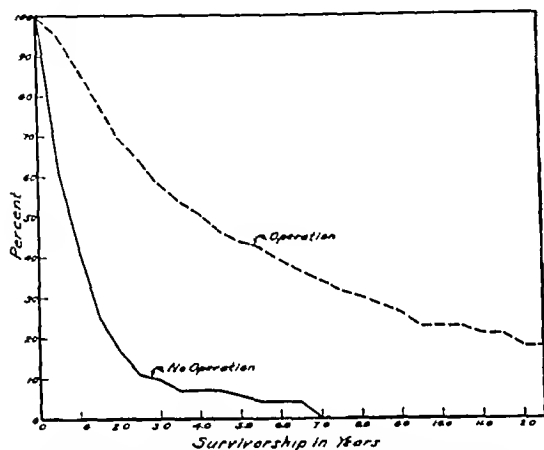


Chart 7 Combined data on patients operated upon and not operated upon for 1925 to 1929 and 1930 to 1934

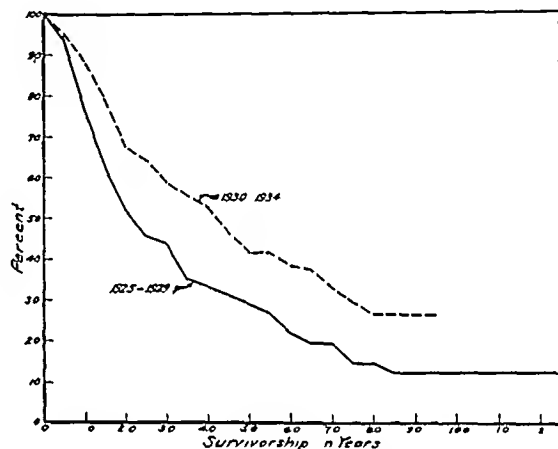


Chart 8 Operation with x ray

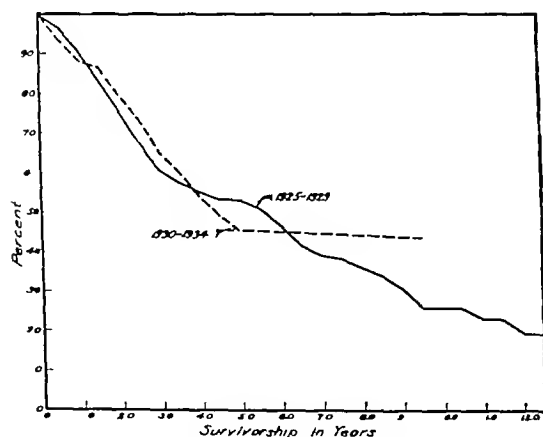


Chart 9 Operation without x ray

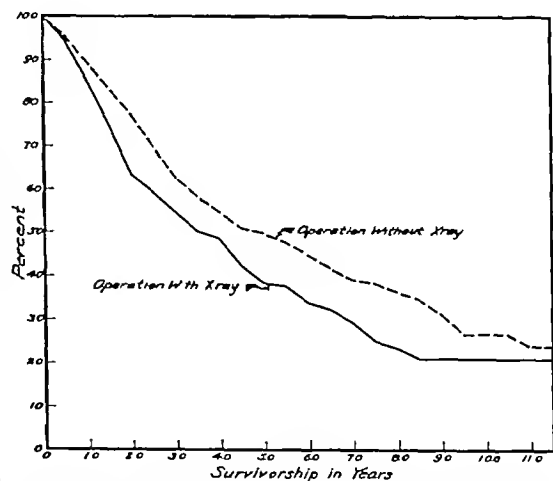


Chart 10 Combined data on patients operated upon with and without x ray during 1925 to 1929 and 1930 to 1934

TABLE IV—SURVIVORSHIP DATA FOR PATIENTS OPERATED UPON TREATED OR NOT TREATED WITH ROENTGENOTHERAPY

Survivor grouping	Cases Total No.	Total number living at end of 5th year	Per cent of total number living	Deaths at end of 5th year	Per cent of deaths only live patients 5th year	Deaths other than cancer	Survivorship per cent according to graph
1 to 1909 Operations with ray	45		27.05	34	6.67		36
Operations without ray	94	30	32.09				32.27
1910 to 1914 Operations with ray		43	34.33	76	30.71	30	24.78
Operations without ray	66	26	37.60	35	26		
1915 to 1921 Operations with ray	279	57	20	19	5		35.86
Operations without ray	69	26	26		25	5	26.77

TABLE V—SURVIVORSHIP AFTER OPERATION OR TREATMENT

Survivor grouping	Number of cases	Metastases	Operation	X-ray	Actual number expected to survive years	Number (all) died years per years	Difference between expected and actual survivorship	Per cent that of those expected to live
1922 to 1929 Curve	54	56	70%	70%			11-45	67.53
Curve		70%	100%	70%	30.51		30	100.00
Curve	30	100%	70%	70%	13			61
Curve	34	70%	70%	100%	27.67		87	36.61
Curve	94	100%	70%	100%	26.23	22	17.26	22.69
1930 to 1934 Curve		70%	70%	60		19	44.24	71
Curve	60	70%	100%	61	30.00		23.86	37.77
Curve	125	70%	70%	64	39		64	67.64
Curve	67	100%	70%	5-13	26.77	17	77	22.67
Curve	53	70%	70%	100%	27.30		26.90	60.23
Curve	60	100%	60				23	21.66
Curve 7	21	100%	70%	100%	67.39	14	7.26	6.3

the beginning of the fifth year as obtained from the curve (9 54). This gives the desired product, 85.23 per cent. The same value would be obtained if a 6 month period, instead of a 1 month period, was used, the method of calculation being identical (00-3.95) $0.8874 = 85.23$ per cent.

In Table II will be found the data for plotting graphs in Charts 3, and 4 which show the survivorship of patients having metastases or no metastases at the time of entrance to the hospital.

The data for plotting graphs in Charts 5, 6, and 7 will be found in Table III and they show

the survivorship for operation and non-operation during both 5 year periods and the year period.

Table IV contains the data for the survivorship for all patients operated upon who were or were not treated with ray during both 5 year periods and the 0 year period.

The data for plotting Charts 3 and 4 will be found in Table V and show the years of survivorship after operation or treatment for both 5 year periods. The per cent who died of those expected to live is found by the following for

$$\text{mobs} = \frac{100 \times \text{difference}}{\text{expected survivors}}$$

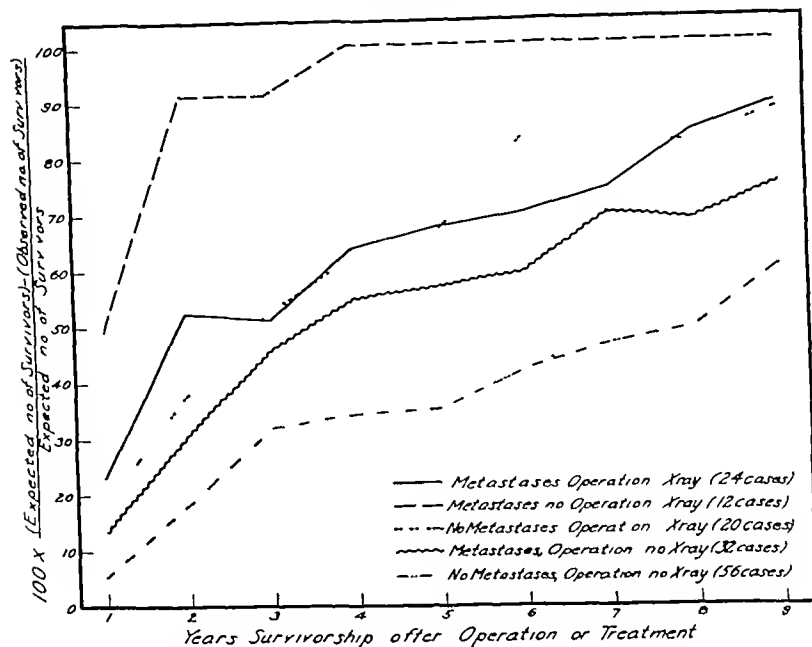


Chart 11 Years of survivorship after operation or treatment for 1925 to 1929 group

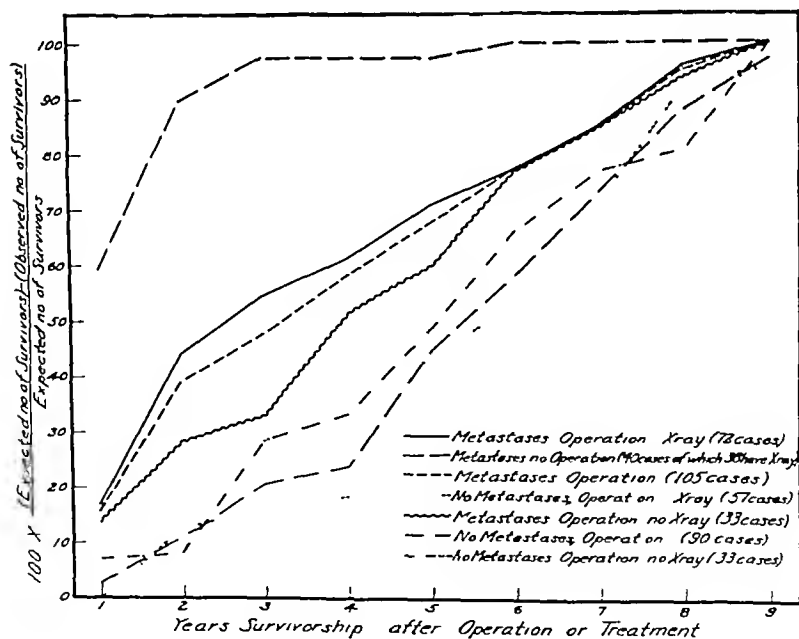


Chart 12 Years of survivorship after operation or treatment for 1930 to 1934 group

Chart 13 shows the years of survivorships after operation or treatment, the data for which will be found in Table VI

The unadjusted curve would make it seem that the 1925 to 1929 group is surviving better than the 1930 to 1934 group. This is because in the

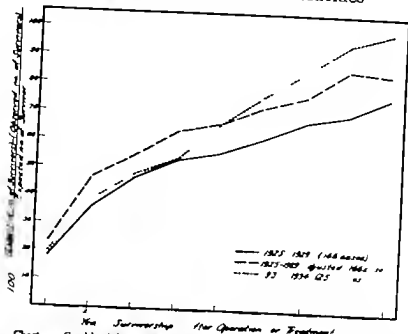


Chart 3. Combined data on survival after operation or treatment for 1925 to 1929 and 1930 to 1934 groups.

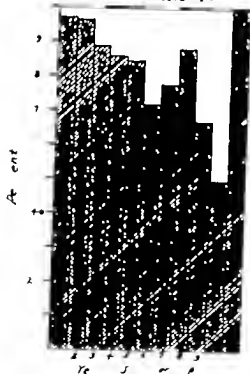


Chart 14. Combined data. Blocked area shows cancer mortality; clear area, mortality from other causes.

1925 to 1929 group 56 cases fell by chance into the best surviving group (no metastasis, operation, no x-ray) and only a few into the worst surviving group (metastasis, no operation, x-ray). This would make comparison unfair. Therefore, the 66 cases were reapportioned so that each surviving group was in the same proportion as that same group in the 1930 to 1934 period. This adjustment makes the two groups comparable. Moreover as only 7 cases have not been traced as living or dead in the 1925 to 1929 group through all of 9 years, and 1 case in the 1930 to 1934 group, with 63 cases in the 1930 to 1934 group not having passed through the 9 year period of observation it can be seen that if these cases were traced, the 1925 to 1929 curve would change but little while the 1930 to 1934 curve would be pulled down to the 0 per cent line by an unknown amount.

It appears from Chart 12 that metastasis cases, with or without x-ray do not survive as well as the non-metastasis cases having x-ray or not. The no operation, with metastasis, with x-ray cases are the poorest survivors in the 1925 to 1929 and the 1930 to 1934 groups. The curves on Charts 11 and 12 had best not be compared pair by pair (for reasons already discussed).

In comparing the total 1925 to 1929 adjusted curve on Chart 3 with the 1930 to 1934 curve on the same chart while it is probable that the 1930

TABLE VI—SURVIVORSHIPS AFTER OPERATION OR TREATMENT

Survey grouping	Number of cases	Actual number expected to survive 5 years	Number that did survive 5 years	Difference between expected and actual survivorship	Per cent that died of those expected to live
1925 to 1929	166	146 51	65	81 51	55 63
1930 to 1934	251	213 93	73	140 93	65 87
1925 to 1929 Adjusted	166	147 98	50 2	97 78	66 08

to 1934 group is surviving better, the difference between the two at best would not be large

From the slope of the normal U S Life Table curve in Chart 1 it appears that after approximately 4 years the cancer patients are dying off at the same rate as the non-cancerous, but this is to be expected since most of the patients with rapid malignant lesions have already died, the greater majority of the remaining cases are made up of inactive and slowly growing tumors, and a large number of this group of patients have attained an age beyond the normal life expectancy for females according to the U S Life Tables for this period, resulting in a survival curve similar to normals of the same age composition. For example, when the surviving patients attain the age of 70 their life expectancy curve would be similar to the curve of normal individuals of the same age composition since they have already exceeded the normal life expectancy of their group in spite of their malignant condition.

The relationship between the groups in which patients died from cancer and the group in which patients died from causes other than cancer is shown in Chart 14. The clear area above the blocking shows the patients who died from other causes definitely proved not to be cancer. In order to evaluate life expectancy in malignant cases it is necessary to follow the patients until death since many patients die from cancer after the fifth year and not from causes other than this disease, as shown in Chart 14.

SUMMARY AND RESULTS

The most striking facts revealed by these charts is that no matter what sort of treatment or

combination of treatments are given to patients having cancer of the breast, patients in *every* group die off much more rapidly than one would expect women of their ages to do, if the United States Life Tables are used as a standard of comparison.

No important differences exist in the survivorship data between the cases in the 1925 to 1929 period and the cases in the 1930 to 1934 period as shown in Chart 13.

The survivorship is significantly less at all stages for the patients showing metastasis on admission than for those patients showing no metastasis.

The survivorship is significantly and increasingly lower for those patients *not* operated upon than for those that received operation.

The survivorship after operation is significantly *lower* for the cases in which roentgenotherapy was used to supplement operation than for cases in which no such treatment was used. This difference, however, is less in the 1930 to 1934 cases than in the 1925 to 1929, a fact which indicates an improvement in the "x-ray with operation" technique in the latter period. This is due in a great part to (1) the selection of cases, since a great number of patients in the surgical group, who had good prognoses were not exposed to roentgenotherapy and practically all those with a poor prognoses were treated by deep roentgen-rays, and (2) in the 1925 to 1929 group, 56 cases fell by chance into the best surviving group (no metastasis, operation, no x-ray) and only a few into the worst surviving group (metastasis, no operation, x-ray), which would make comparison unfair.

SYMPOSIUM UROLOGY

UROLOGICAL ASPECTS OF HYPERTENSION

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TODAY the medical profession is acutely alive to the challenge of hypertension. The internist, surgeon, neurologist, ophthalmologist, and urologist are busily engaged in tracking down the causes of this scourge of mankind. The problem of human so-called essential hypertension, which means sustained elevation of blood pressure without known or at least demonstrable cause, is being faced resolutely and it is certainly not beyond reasonable expectation that its source will ultimately be made clear.

Even though the causes of this condition are not known or at least are surmised only vaguely, relief of some of its more distressing effects is already in the hands of the surgeon.

Secondary hypertension or that caused by some known condition or disease on the other hand, becomes by that very fact more amenable to relief by either medical measures or surgical attack. It has long been recognized that the kidney may be the organ at fault as it is known that secondary hypertension occurs more frequently in association with disease or derangement of this organ than with that of any other organs. Richard Bright, in 1836 even before the days of blood pressure estimation, was the first to note the relation of renal disease to hypertension.

In 1873 Gull and Sutton demonstrated widespread organic disease of the smallest arteries and capillaries of the kidney and seriously considered those changes as the primary cause of the increased peripheral resistance hypertension, and cardiac hypertrophy.

Since that time the literature has been crowded with clinical and experimental evidence of the rôle the kidney plays in the production of hypertension.

CAUSE OF SECONDARY HYPERTENSION

From the urologist a few points the causes of secondary hypertension may be put into 3 main

From the Department of Urology, Royal Victoria Hospital.
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categories or classifications: (1) Intrinsic disease of the kidney; (2) obstructive disease or conditions involving the upper or lower urinary tract; and (3) the adrenal gland. Intrinsic diseases of the kidney are glomerulonephritis, pyelonephritis, congenital polycystic kidneys, and sclerosis of renal arteries and arterioles, or the so-called renal ischemia. Urinary obstruction consists of prostatic and other obstructive and infective conditions of the upper and lower urinary tract. In the adrenal gland we encounter adrenal pheochromocytoma.

Glomerulonephritis and pyelonephritis. In his search for the cause of hypertension the urologist must always bear in mind parenchymal kidney disease and its sometimes close resemblance to chronic pyelonephritis. That organic arteriolar disease of the kidneys, glomerulonephritis, may be the cause of hypertension is an old belief of the medical profession, and the literature is bound with proof that it is so.

In 1930 Bell and Pedersen in a article discussing the cause of hypertension, noted the fact that up to that time no cases of pyelonephritis had been reported as the cause of hypertension. Longcope and Winkler (26) in 1933, drew attention to the occasional patient with supposed chronic nephritis who died with uremia and showed at autopsy to have in reality a bilateral pyelonephritis, contracted kidneys, and irregularly dilated renal pelvises. They report 9 such cases, in 5 of which there was hypertension. The authors did not, however, lay emphasis on the pyelonephritic disease as the cause of the hypertension.

In 1937 Longcope (25) contributed an excellent article on the origin of chronic bilateral pyelonephritis and its association with hypertension. Of the 2 cases he reports, 12 showed hypertension, which usually came on in the later stages of the disease and combined with chronic renal insufficiency. He suggests that the failing renal function is not necessarily a factor in producing

the hypertension, but that arteriolar disease is very suggestively so, because the hypertension is combined with hemorrhagic retinitis and arteriolar lesions of the fundus in a large percentage of the cases

In the same year A M Butler reported 15 cases of pyelonephritis in children, 8 of whom had hypertension averaging 190 millimeters of mercury systolic, and 140 millimeters of mercury diastolic Butler believes that clinical evidence also demonstrates that hypertension is sometimes associated with pyelonephritis before there is an appreciable diminution in renal function And he further states that the hypertension, which is secondary to a unilateral pyelonephritis, may disappear after nephrectomy of the involved kidney He reports 2 cases of unilateral pyelonephritis associated with hypertension, in each of which the hypertension disappeared after nephrectomy of the diseased kidney While these are among the first such cases to appear in the literature, urologists are now very much alive to the possible association of unilateral kidney disease with hypertension, and the literature already reflects that fact

In July, 1939, D W McIntyre reported a case of unilateral chronic pyelonephritis with arterial hypertension in a young man apparently cured by nephrectomy He mentions 2 other such cases improved by nephrectomy

Crabtree and Prien in a recent article, read at the May, 1939, meeting of the American Urological Association, mention the apparent infrequency of reported cases of hypertension in unilateral infections of the kidney as recently as a year previously, but they note that since the subject has become current they themselves know of 11 other local, unreported cases The authors in this very excellent article, "The Nature of the Renal Injury in Acute and Chronic Colon Bacillus Pyelonephritis in Relation to Hypertension," observe that the data on which is based the condemnation of the pyelonephritis as a factor in the production of hypertension have been observed almost entirely in chronic late, and terminal conditions They exhort urologists to review their acute pyelonephritis cases as to the cardiovascular systems and hypertension, to study carefully the early pathology, and to note evidence of vascular damage whenever possible in order to determine similarity with known factors concerned in the production of experimental hypertension, and also to observe what types of cases are prone to hypertension

Crabtree and Prien give a timely warning to urologists against rash surgery in following words

"The experimental and clinical evidence which is now available is inadequate to place the subject of hypertension on a surgical basis A hasty rush to attempt surgical relief of hypertension can but result in harm until further facts have been collected and their significance translated into clinical terms There is at present nothing to indicate whether it is the initial injury from the initial infection, a continuous injury associated with continuous destruction of renal cells of the kidney, a renal injury which sets in motion, through renal deficiency, a process of renal destruction through unexcreted waste products, or, a deranged physiology in poorly nourished renal cells, which is the potent factor in hypertension Until these factors are sorted and further data supplied, surgery for hypertension must remain in the realm of experimental operations"

Congenital polycystic kidneys The association of hypertension with the so called congenital polycystic kidney is common knowledge The condition may be overlooked for a long time until an acute hematuria or renal or ureteral colic directs attention to the urinary tract, at which time the bilaterally, cystically enlarged kidneys are found It resembles chronic glomerulonephritis, but its victims frequently live longer than the nephritics even though they carry a marked blood chemistry concentration and low phenosulfonphthalein output for years Approximately 45 per cent of a series of 33 cases of polycystic kidneys reported from our service by Hawthorne and Rauscher (19) showed hypertension Fishberg puts the percentage between 65 and 75, this high figure is shown in cases usually with marked advanced, renal parenchymal destruction

Sclerosis of renal arteries and arterioles, so called renal ischemia The experiments of Goldblatt and his co-workers in the production of experimental hypertension by the induction of renal ischemia are of exceptional interest to urologists and are of great significance to them clinically These workers produced renal ischemia in dogs and monkeys by means of a special clamp applied to the renal arteries, and immediately an elevation of systolic and diastolic peripheral blood pressure was caused which lasted for a month or more, and in some instances even over a period of 5 years Goldblatt proved by various experiments that the ischemic kidneys are in some way directly responsible for the development of the experimental hypertension Perhaps the most striking of these is that if one kidney is transplanted in the neck or inguinal region, and the other kidney is removed, constriction of the arterial blood supply of the transplanted kidney results in the development of hypertension

Goldblatt states that there are two known mechanisms of development of experimental hypertension induced by renal ischemia (1) A nervous reflex from the ischemic kidneys which

affects the general vasomotor apparatus (2) a humoral mechanism initiated by the ischemic kidneys caused by an accumulation in the blood of a substance which acts directly or indirectly to constrict the peripheral vessels.

Goldblatt's experiments failed to establish the nervous reflex as the mechanism responsible for the increased peripheral resistance, but they did tend to show that a humoral mechanism was the cause of the vasoconstriction and the consequent hypertension. Since the publication of his work a number of clinical instances which tend to substantiate the experimental work have appeared in the literature. In 1938 Leadbetter and Burkland reported a case of sustained hypertension caused by disturbance of the arterial circulation of an ectopic right kidney in a colored boy of 5½ years of age. There was no pyelonephritis or coarctation of the aorta. Nephrectomy relieved the hypertension. Pathological examination of the removed kidney showed the lumen of the renal artery reduced to a mere crescentic slit by a mass of smooth muscle tissue—an anomaly of the renal artery.

In 1938 in an article published simultaneously with that of Leadbetter and Burkland, Boyd and Lewis reported a case of arterial hypertension relieved by nephrectomy. In their case Boyd and Lewis thought that the hypertension was caused by an adrenal tumor. Both adrenals and kidneys were explored and a right nephrectomy was done on what appeared grossly to be a tumor of the kidney. Section revealed an infarction of the upper half of the anterior surface of the kidney with a marked thickening of the arterial walls of the renal pedicle.

Mulholland, in an article at present in the process of publication, calls attention to the increased recording of cases of renal artery thrombosis, and mentions 1 such case reported by Weltz. He brings out the fact that the condition is most often mistaken for some acute intra-abdominal condition, and that early recognition might quite likely prevent the advent of hypertension. Also in 1938 Freeman and Hartley reported hypertension in a patient with a solitary ischemic kidney. The patient died and necropsy showed an atheromatous plaque partially occluding the lumen of the artery of the solitary kidney.

It is quite evident from the above citations that pathological conditions of the renal arteries causing hypertension have been in most instances accidental findings and that diagnosis, except for perhaps thrombosis of the renal artery offers many difficulties and can in the main be only conjectured.

Urinary obstruction. Obstructive conditions of the urinary tract have long been known to be accompanied at times by elevation of the blood pressure and changes in the heart. It is generally recognized that relief of the obstruction results in a lowering of the peripheral vascular tension.

In 1920 and 1923 O'Connor observed a fall of blood pressure in 74 hypertensive urinary obstruction cases following relief of obstruction.

One of us (33) in 1931 also showed a marked fall in blood pressure following drainage in 128 cases of prostatic with hypertension.

The definite rôle played by urological conditions in hypertension has recently been shown by Maher and Wosika. They reviewed 600 cases of hypertensive cardiac disease and found 101 patients, or 16.8 per cent, with urological lesions, whereas only 4.34 per cent of the series were found due to parenchymal renal disease, the commonly accepted cause of hypertension. The basic lesions were those of obstruction, infection, or a combination of both the obstruction was pre-dominantly in the lower urinary tract. In the males they were principally prostatic. Maher and Wosika believe that hypertension is associated with urological pathology more often than is ordinarily believed and that investigation of the urinary tract is indicated in hypertension of unknown origin.

Phaeochromocytoma of the adrenal. In the urologist's search for the cause of hypertension, new growth or other changes in the medulla of the adrenal gland must be considered. Certainly no more interesting problem falls to his lot.

Recognition of the train of symptoms of paroxysmal hypertension is comparatively recent in medical history. Labbe and co-workers gave the first clear picture in 1922. Since that time the subject has been thoroughly gone into by such investigators as Belt and Powell and Edward in the American, Gertner in the German and Donzelot in the French, literatures. In 1938 one of us (37) with McEachern reviewed the literature then extant, reported a case in detail and carefully tabulated 20 cases reported in the literature in which patients had been operated upon, including our own successful case.

METHODS OF DIAGNOSIS, RENAL PHYSIOLOGY TREATMENT

The diagnosis of those conditions of the urinary tract and the adrenal gland associated with hypertension may offer some difficulty to the urologist, mainly in arriving at an accurate estimation of the localization and extent of the lesion rather than the type of the lesion concerned. It should

not be necessary to insist that a carefully taken history is of prime importance. It must not be forgotten that aside from the so called urological symptoms common to pathological conditions of the urinary tract, the general complaints and symptoms are to be thoroughly developed. A complete physical examination to include blood pressure readings taken several times daily at stated intervals to determine the stability of the hypertension, electrocardiographic studies, ophthalmological investigation of the fundus and visual fields, and finally a searching, urological examination should all be carefully performed.

The urological examination must envisage a careful estimation of the renal function by such tests as the phthalein, Mosenthal, urea clearance or concentration tests, and the usual blood chemistry estimations, and it is only after one has obtained data on the functional capacity of the kidney, that intravenous urography or retrograde pyelography is permissible. There is no question in our minds but that the media used in these two latter procedures may in certain instances be definitely irritating to the kidney itself and to the remainder of the urinary tract.

The clinical pictures of those urological conditions considered to be accompanied sometimes by hypertension, are now well defined and readily recognized. The real problem for the urologist is to determine whether or not the lesion is unilateral, and if unilateral, what the extent of such involvement is. This involves an accurate estimation of the separate functional capacity of each kidney. At the present time the ordinary phthalein and indigocarmine tests used in the differential determination of unilateral disease lack preciseness. Physiologists are coming to our aid and already newer methods of determining kidney physiology have been devised. Homer W. Smith, in a recent publication, reviews these new aspects of renal physiology. He shows that besides the known processes of filtration and re-absorption, a third process has been established, namely, the process of tubular excretion by which the tubular cells remove certain substances from the blood and deliver them directly into the tubular urine. It is now known that those substances universally used by urologists, phenosulfonphthalein and the organic iodine compounds, diodrast, hippuran and iopax, are eliminated by the process of tubular excretion.

Smith pays tribute to the debt that renal physiology owes to urology for the introduction of these products and says

"It has in the first instance, been possible by the use of diodrast to devise methods for measuring the physiologi-

cally effective rate of renal blood flow in man over prolonged intervals of time, the requisite data being only the concentration of diodrast in the blood, and the quantity of diodrast excreted per minute. In the second instance, it has been possible to devise methods for measuring the total quantity of intact tubular tissue in the kidneys (tubular excretory mass), the essential operation being the measurement of the rate of excretion of diodrast when the tubules are saturated with this compound and hence excreting it at a maximal rate. The measurement of effective renal blood flow and of the tubular excretory mass would seem to hold considerable promise in the exploration of normal renal function and the nature and cause of renal disease."

Smith continues to discuss the various clearance methods by means of which the filtration rate, the renal blood flow, and the total tubular excretory mass of the normal human kidney are measured. He feels that the ability to measure the renal blood flow has a special aptness in view of the work of Goldblatt on renal ischemia.

While these tests, as constituted at present, are not as simple as might be desired there is great hope that greater simplification and, therefore, more widespread use will not long be delayed.

We, therefore, emphasize careful study of the hypertensive case, as exact an estimation of the extent of the lesion as possible, and the adding to the admonition of Crabtree and Prien whatever weight our word may have, that urologists must not hastily or indiscriminately resort to surgery in the hypertensive patient.

At the present writing nephrectomy is the common surgical procedure used in combating hypertension associated with unilateral kidney disease. It is certainly not impossible that newer and finer methods of estimation of kidney physiology allowing the early diagnosis of renal vascular pathology will be perfected and will result in the devising and utilizing of more conservative surgery.

Goldblatt in his work on experimental hypertension observed that in those animals in which hypertension had returned to a lower level after the clamping of the renal artery, it was due either to an inadequate clamping of the artery, or the development of an effective accessory circulation by way of the ureteral and capsular vessels. He noted that if the kidney were decapsulated before clamping the artery, the accessory circulation became pronounced and interfered with the development of hypertension. Further, animals have survived for years by means of the accessory circulation when both renal arteries have gradually been closed off completely. Goldblatt himself suggests that in the clinical application of the production of an adequate accessory circulation, it would be more apt and effective in those cases in which the hypertension is due to sclerosis of the main renal arteries or the larger branches.

Paunz, in 1930, demonstrated that in the dog a new blood supply to the kidney can be established by omentopexy as likewise did Professor Heymans. Abrami, Iselin, and Robert Wallach, in January 1939, reported unilateral nephro-omentopexy in 2 cases of hypertension of renal origin. In both cases the blood pressure was lowered only temporarily but subjectively each patient was benefited. While the authors feel they have failed in these particular instances, they believe that the method holds promise.

Likewise, Homer Smith in the article quoted above mentions 2 hypertensive patients on whom renal omentopexy was performed without having convincing evidence of improvement of the renal function.

In the search for the cause of the hypertension in the adrenal gland a number of well known procedures are used, namely: (1) The flat plain film showing both diaphragms with soft tissue shadows above the kidneys or unusual distance between diaphragm and upper pole of kidney. (2) Intravenous urogram and retrograde pyelogram to visualize displacement of the kidney or distortion of it by an adrenal new growth. (3) Perirenal insufflation of air to visualize kidney and adrenal. (4) Surgical exploration.

It will nearly always be found necessary to use all methods to come to definite conclusions about the given case.

The third procedure, air infiltration, was first suggested by Carell in 1919 and modified by Cahilli in 1935. When successful it gives admirable confirmatory evidence, but it is also misleading at times and is a measure to be used with some caution. The danger is air embolus. Hawthorne and Tidmarsh (20) are reporting such a case in a girl years old with hypertensive cardiac disease, who died suddenly during an air injection to delineate the adrenals. Autopsy revealed the right heart filled with air emboli. Both adrenals were the seat of pheochromocytoma with adrenal content of about 6 times the normal amount.

Recently Brodney and Chamberlin have devised an instrument calculated to minimize the danger from air embolism.

The fourth measure, operative exploration, may be the final court of appeal. The usual measures recognized are: (1) Exploration by abdominal section at which time both kidneys and both adrenals may be palpated and (2) loin incision as for kidney on one or both sides.

It is not at all unlikely that unsuspected conditions of the adrenal or of the kidney may be found in the future to be the cause of that which at first appears to be an essential hypertension. The

surgeon or neurosurgeon in his attack on essential hypertension by sympathectomy would be well advised to use the subdiaphragmatic loin incision of Adson as this approach allows an excellent exposure of the adrenal and the kidney as well as ease of exposure of the sympathetic chain.

Blinger and Craig report the case of a young woman with essential hypertension. A splanchnicectomy on the left was done. Twelve days later there was a similar operation on the right. A marked drop of blood pressure occurred during the second operation, the patient's condition became poor and a transfusion was given. The left adrenal was palpated through the unopened perirenal capsule and seemed normal. After this second operation the blood pressure rose rapidly again, and it was thought that a hemorrhage had possibly occurred around the adrenal. The wound was re-opened, the adrenal was explored and found to be the seat of a new growth. On removal of this growth blood pressure dropped to the normal limits and remained so.

What is desired to be emphasized here is that in the surgical attack on essential hypertension by splanchnicectomy the kidney and adrenal must be thoroughly exposed and examined and that surgeon, neurosurgeon, and urologist should work as a team rather than attempt to achieve glory separately.

CLINICAL CONCLUSIONS

It is abundantly evident that hypertension in patients with pyelonephritis is relatively common. When unilateral and in the advanced stage removal of the kidney has in many cases reduced the pressure permanently. In our clinic we have frequently had such results, and many other clinics report similar findings.

Certain pertinent questions naturally suggest themselves. What is the factor in this pathology that produces the hypertension? What can be done in the early cases of this infection to determine this factor? In such early cases nephrectomy is surely not justifiable but in cases in which a destroyed kidney is removed a more thorough examination of the specimen, especially the vascular system, should be made.

Many of these kidneys are found in very young patients and are of the small contracted type. In such cases, certainly in the ischemic group, a congenital element may in a measure be responsible.

Until these questions can be answered more satisfactorily surgery in the early cases must still be regarded as in the experimental stage. In the polycystic kidneys any surgery for hypertension is to us questionable at present.

In obstructive lesions the procedure is much clearer and the relief of the obstruction is always indicated

Finally, the pheochromocytoma group are difficult and delicate of diagnosis and treatment and require the utmost thoroughness and caution. But while diagnosis is often difficult, it has nevertheless recently made eminently satisfactory progress and today because of this progress the profession is acquiring a more thorough knowledge of these conditions, and the results, surgical and otherwise, are proving most successful

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COMPLICATIONS AND DANGERS OF LOWER URETERAL CALCULI

JOHN L. ORMOND A.B., M.D. F.A.C.S. Detroit, Michigan

THE majority of patients with ureteral calculi will, after a more or less stormy and uncomfortable time pass their little stones spontaneously. Often the most difficult part of the treatment is in persuading the patient that masterly inactivity is the proper program. The pain is often so violent that at first he is convinced his condition is dangerous, and it is necessary to disabuse his mind of this idea; then, when his fears are allayed, the pain of acute attacks, which he may continue to have, may be so trying that he is apt to feel he is being neglected. Complete confidence in his physician and complete understanding of the situation are essential for patient equally important is a definite, unmistakable diagnosis on the part of the physician.

Even when the diagnosis has been made beyond possibility of mistake, when a clear idea of the probable course of events has been given to the patient, and when he has been shown that the pain, or at least one aspect of it, is desirable as an evidence that his tormentor is on the move, even then he may become impatient of the slowness of the course of events, and insistently attempt to push the surgeon into action against his better judgment. It is impossible to tell how long the ordeal will last; the stone may pass in a few hours or a few months.

In many of these patients the course of the stone can be traced by the progress of the pain even without the evidence of a roentgenogram. First pain in the back may come due to pelvic distention. The sharp pain may run then over the iliac crest down to the inguinal region to the inner surface of the thigh, to the acrotum and testicle, or vulva. At first, even though the urine contain red blood cells, there may be no urinary symptoms but later frequency occurs and marked urgency may mark the lodgment of the stone in the lowest part of the ureter and its expulsion into the bladder. As the stone passes through the urethra it may cause pain or a sudden stoppage of the urinary stream followed by an explosive expulsion of the stone with relief of the urinary symptoms. This progression is familiar to all.

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Unfortunately not all patients pass through these stages. A few stones lodge in the upper ureter but more in the lower or pelvic ureter and it is with these latter that we are concerned.

When a patient has a stone lodged in the lower ureter, the surgeon's problem is to decide whether immediate operation is desirable, or whether it is possible to temporize and either do nothing, or attempt to facilitate the passage of the stone by cystoscopic manipulation. The data on which he must base his decision are the size and position of this stone, the duration of the impaction, the condition of the affected kidney and of the one on the opposite side, the general condition of the patient, and, finally, a clear knowledge of the dangers and complications of lower ureteral calculi.

These complications and dangers can be divided conveniently into 3 groups: first, those due to the presence of the stone itself; second, those attendant on efforts at manipulative removal; and, third, those attendant on operation.

Group 1: Those associated with the stone itself are (1) mistaken diagnosis, (2) hydro-ureter, (3) hydronephrosis, (4) pyelonephritis, acute and chronic, (5) uremia, (6) hemorrhage, (7) increase in size of the stone, (8) ureteral stricture, (9) per-ureteritis, (10) peri-ureteral abscess, (11) keratinization through the ureteral wall, and (12) fistula.

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Hydro-ureter, hydronephrosis, pyelonephritis, and uremia can all be considered together since

They are all dependent on the obstruction of an impacted stone. These consequences of obstruction are those most to be guarded against of all the complications of stone, and are the ones which chiefly limit the possibility of temporizing in the treatment of stones. In nearly every case of impacted calculus there is some grade of dilatation of the ureter above and of the pelvis. The greater the obstruction and the longer it lasts, the greater this dilatation and consequent damage to the kidney. Fortunately, most stones, even the large ones, are channelled and there is also a condition of suspended function of the kidney which has been termed hibernation by Dourmashkin. This seems to be conservative, in that there is present temporary cessation of the increase in the pelvic pressure.

Even in instances in which the stone has been present for long periods, there is the possibility of at least partial recovery of renal function after its removal. This is not always the case, and in each instance the observer is faced with a nice question of judgment as to how long he may safely temporize. Of course with the very large stones temporizing is foolish, but it is with the borderline cases we are most apt to do so.

Fortunately we now have at our disposal intravenous urography, a convenient and painless method of watching the rate of both pelvic dilatation and of diminution of function.

With a normal kidney on the opposite side we are reasonably safe, for a kidney can stand considerable punishment. Experimental work seems to show that some degree of restoration of function is possible after the relief of complete obstruction which has lasted not more than 30 days. But when the opposite kidney shows much reduced function or absence of function, temporizing may be disastrous. In this connection I should like to cite a personal experience.

CASE 1 A young man about 25 years old entered the hospital on a Monday night complaining of having had left sided pain for 24 hours. The roentgenogram showed a shadow in the region of the lower left ureter. On cystoscopy obstruction was found at the left ureterovesical junction and no sign of the right side of the trigone nor of the right ureter. During 24 hours he passed only 200 cubic centimeters of urine, and the non protein nitrogen of the blood rose slightly. On Wednesday another effort was made to manipulate the stone, and it was decided to operate the next day, provided the stone did not pass. During the night, however, his condition, which had previously seemed fairly good, changed suddenly. Edema of the lungs developed, an emergency nephrostomy was done, but he died within a couple of hours. Unfortunately, no autopsy could be obtained, but we believe that it was a case of congenital absence of the right kidney and ureter. The patient undoubtedly should have been operated upon the day he entered the hospital.



Fig 1. An unusually large calculus in the lower ureter of a man. This could be palpated through the rectum. After removal there was some functional recovery of the kidney above.

We have had another patient with a solitary kidney due to a previous nephrectomy, who required emergency nephrostomy, and others with damaged or absent contralateral kidneys who developed mild uremia when a stone was lodged in the lower ureter.

Either at the onset of impaction or later there may be an acute infectious reaction with chills and high fever, subsiding into a condition of chronic pyelonephritis, with continued pyuria if the obstruction is not complete. This condition combined with distention can cause a rapid destruction of the functioning capacity of the kidney.

Recently we have been hearing a good deal about the effect of unilateral renal lesions in the production of arterial hypertension. Most of the cases reported have been associated with a disturbance of renal circulation, but there are a few cases on record in which relief of unilateral obstruction seems to have had a salutary effect on general arterial hypertension.

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Increase in size of the stone must occur. Certainly some of the stones we see in the lower

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(4) kink, (5) infection, (6) movability, (7) over-looking stone or part of it, and (8) fistula

The dangers of pneumonia, phlebitis, and other complications of all operative procedures must be faced, but we are concerned here with only those attending this particular operation

There is almost certain to be urinary drainage for a longer or shorter period and very occasionally a true fistula results depending often on stricture formation below, either pre-existing or resulting from operative damage to the ureter. This is rare. Occasionally the scar resulting from the drainage tract may draw the ureter out of the normal path causing a kink. On one occasion, we were unable to pass an ordinary catheter up past the kink. However, on making a smooth wax bulb on the end of a bougie we were able to pass it, thus straightening the ureter and relieving the partial obstruction which had resulted.

In any drained wound there is of course a certain amount of infection, and whenever urine drains for a time, particularly if the urine is itself infected, the infection occasionally may amount to an abscess.

Movability of a stone may cause embarrassment, for if the ureter above is much dilated, the stone, if round and reasonably smooth, may move back into the ureter and not be found at operation. We invariably have a roentgenogram taken on the way to the operating room to make certain of the position of a stone, but in spite of this precaution, we had the embarrassment on one occasion to be forced to operate a second time to remove a stone which had returned to the pelvis. On another occasion a large stone had moved upward, but in this case we found a much dilated ureter above a dense stricture at the ureterovesical juncture and felt it best to cut the ureter above and re-implant it into the bladder, in consequence of which, the stone was expelled into the bladder a couple of days later. It is possible that portions of stones may be left behind, though if catheters or uterine probes be passed both ways from the operative incision this is unlikely to occur.

Troublesome bleeding may occur from the veins about the bladder, but dangerous hemorrhage is rare. However, erosion of the iliac artery has occurred. Moschkowitz some 30 years ago, reported bilateral erosion of external iliacs following bilateral ureterolithotomy due to rubber drains. More recently de la Marnierre reported an instance of hemorrhage from one iliac 15 days after removal of a drain, which had been allowed to remain in place only 2 days. This past year we have had a very unpleasant experience which is worth detailing.

CASE 2 After the removal of a stone from the lower left ureter of a man aged 55 years, the wound healed slowly, repeatedly broke open, and ureteral obstruction recurred which required repeated dilatation. At the end of 9 weeks the wound was still draining. One evening as the resident lifted off the dressings, there was a spurt of blood as if from a small hose. He immediately made pressure on the iliac through the abdominal wall and sent for assistance. Abdominal pressure was maintained until an operating table could be brought to the room. There the wound was tightly packed, the abdomen opened, and the external iliac artery ligated. Twenty days later it was necessary to amputate the left leg between the ankle and the knee due partly to the ligation of the external iliac and partly to a pre-existing disease of the veins of this leg.

CONCLUSIONS

If all patients with lower ureteral calculi were neglected, the great majority would recover unscathed. But a few would suffer more or less serious harm and this harm we wish to prevent.

Each case of ureteral calculus, therefore, presents the following questions: Is immediate operation desirable? If not, should manipulation be tried? If so, what method should be used? How long is it safe to temporize?

Each must be guided by his own experience, judgment, and skill. I have come to the conclusion that only the less drastic forms of manipulation are indicated. Patients with stones, the expulsion of which cannot be stimulated by the gentler measures, should be operated upon when and if the stones have been given a reasonable opportunity to be expelled. The time constituting a reasonable opportunity will be measured by the amount of disability caused by the pain, and by careful evaluation of the damage produced. I have seen a stone lodged in the lower ureter expelled after 6 months of careful observation. This stone caused in that time only 4 days of disability and no appreciable damage to the kidney. On the other hand, I am afraid that some patients treated by multiple manipulations have been subjected to more danger, have suffered more pain, and lost more time, than if they had been operated upon in the first place.

In all cases, whether operative or not, attempts to prevent recurrence should be made. Ureteral dilatation, pelvic irrigation, treatment of infection, attention to diet, fluid intake, and to changing urinary reaction will usually prevent recurrences.

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ureter could not have reached that position in their present dimensions. Fortunately for the preservation of renal function, these large stones are often channelled and after their removal, the affected kidney may be at least partly restored to health. We had an example of this in a male patient with an exceptionally large stone which was easily palpable by rectum. A few days after its removal the phthalein test showed returning function in the kidney above.

Stricture of the ureter is thought by some to cause stones, by others to cause their impaction, and by still others to be caused by irritation by the stone. Probably all 3 are true in individual instances. It is certainly true that many stones are associated with strictures, the dilatation of which is an important part of their therapy either as an aid to their passage or to prevent post-operative recurrence.

Ulceration, peri-ureteritis, peri-ureteral abscess, and fistula may be considered together, since they are different stages of one process. All are familiar with the thickened ureter and the inflammatory reaction so often found around the stone at operation. Cases are on record of ulceration through the ureter causing abscesses which have burrowed and ruptured in the back, perineum, inguinal region, and thigh, sometimes with the discharge of the stone. Fistula occasionally results. Ockerblad recently reported a uretero-vaginal fistula caused by the spontaneous ulceration of a stone. However nowadays treatment is usually instituted before the condition has advanced beyond a rather mild peri-ureteritis.

Group 2. Complications and dangers attending efforts at non-operative removal are the following:

- (1) injury to ureteral mucosa, (2) stricture,
- (3) perforation of ureter, (4) peri-ureteritis,
- (5) peri-ureteral abscess, (6) temporizing too long,
- (7) hemorrhages, and (8) accidents such as loss of filiform, breakage of instrument, and catching, looping, or knotting of catheter.

Non-operative methods of removal or manipulation consist of various procedures dilating the ureter below the stone, passing catheters or bougies past the stone, injecting various substances into the ureter above the stone, engaging the stone in various devices such as corkscrew spiral wires, or multiple cords, and retrolithotomy by means of the cystoscopic scissors or the cutting current. Any of these may cause slight injury to the mucosa, usually of no consequence but occasionally so. A stricture may result. Perforation of the ureter by bougie or by a catheter containing a stylette in the absence of infection has occurred without harm. On the other hand the ureter may

be perforated by the metal instruments and peri-ureteritis and abscess result. We have seen 1 such case.

Another possibility is breakage or separation of a portion of the instrument within the ureter or the catheter or other device may knot itself above the stone and be difficult to withdraw. I have seen one instance of the latter in which, fortunately at the end of 24 hours it was withdrawn readily. I have also seen the filiform of the Walther dilator unscrewed and left in the ureter from which it was expelled spontaneously at the end of 4 days. This, however was not a case of stone.

It seems best not to use these devices for the purpose of forcibly extracting the stone, but merely to engage it, thus dilating the stone and stimulating or facilitating its expulsion. There is less possibility of damaging the ureter by so doing, than by attempting forcible extraction though I have seen stones at the ureteral meatus dragged out without harm.

Another danger of manipulation is the possibility of temporizing too long. Each manipulation arouses expectation of expulsion and, as in the case cited earlier, the period of watchful waiting may be prolonged beyond the safe point. Under ordinary circumstances the size of the stone and the availability of the patient are the determining factors. Most stones of less than 1 centimeter in the narrowest dimension will pass, and fairly prolonged temporizing may be permissible, provided obstruction is not marked. However, with stones of this size or even smaller if the patient lives at such a distance that frequent observations are not possible, the period of temporizing may be very short and resort had to operation earlier.

With larger stones one is occasionally astonished at the effect of manipulation. At the urgent solicitation of one patient we unwillingly manipulated a large stone in the lower ureter and proceeded, nevertheless, with our preparations for its operative removal the next day. However the roentgenogram on the way to the operating room the next day showed that the stone had passed into the bladder from which it had to be removed by the lithotrite.

Meatotomy performed either with cystoscopic scissors or by means of the cutting current may facilitate the passage of a stone, but occasionally results in troublesome, though not dangerous, hemorrhage. In on such case removal of blood clots from the bladder by suction proved necessary.

Group 3. Complications and dangers of operative removal are (1) ordinary operative complications, (2) hemorrhage, (3) stricture,

(4) kink, (5) infection, (6) movability, (7) over-looking stone or part of it, and (8) fistula

The dangers of pneumonia, phlebitis, and other complications of all operative procedures must be faced, but we are concerned here with only those attending this particular operation

There is almost certain to be urinary drainage for a longer or shorter period and very occasionally a true fistula results depending often on stricture formation below, either pre-existing or resulting from operative damage to the ureter. This is rare. Occasionally the scar resulting from the drainage tract may draw the ureter out of the normal path causing a kink. On one occasion, we were unable to pass an ordinary catheter up past the kink. However, on making a smooth wax bulb on the end of a bougie we were able to pass it, thus straightening the ureter and relieving the partial obstruction which had resulted.

In any drained wound there is of course a certain amount of infection, and whenever urine drains for a time, particularly if the urine is itself infected, the infection occasionally may amount to an abscess.

Movability of a stone may cause embarrassment, for if the ureter above is much dilated, the stone, if round and reasonably smooth, may move back into the ureter and not be found at operation. We invariably have a roentgenogram taken on the way to the operating room to make certain of the position of a stone, but in spite of this precaution, we had the embarrassment on one occasion to be forced to operate a second time to remove a stone which had returned to the pelvis. On another occasion a large stone had moved upward, but in this case we found a much dilated ureter above a dense stricture at the ureterovesical juncture and felt it best to cut the ureter above and re-implant it into the bladder, in consequence of which, the stone was expelled into the bladder a couple of days later. It is possible that portions of stones may be left behind though if catheters or uterine probes be passed both ways from the operative incision this is unlikely to occur.

Troublesome bleeding may occur from the veins about the bladder, but dangerous hemorrhage is rare. However erosion of the iliac artery has occurred. Moschkowitz some 30 years ago, reported bilateral erosion of external iliacs following bilateral ureterolithotomy due to rubber drains. More recently de Marnier reported an instance of hemorrhage from one iliac 15 days after removal of a drain which had been allowed to remain in place only 2 days. This past year we have had a very unpleasant experience which is worth detailing.

CASE 2 After the removal of a stone from the lower left ureter of a man aged 55 years, the wound healed slowly, repeatedly broke open, and ureteral obstruction recurred which required repeated dilatation. At the end of 9 weeks the wound was still draining. One evening as the resident lifted off the dressings, there was a spurt of blood as if from a small hose. He immediately made pressure on the iliac through the abdominal wall and sent for assistance. Abdominal pressure was maintained until an operating table could be brought to the room. There the wound was tightly packed, the abdomen opened, and the external iliac artery ligated. Twenty days later it was necessary to amputate the left leg between the ankle and the knee due partly to the ligation of the external iliac and partly to a pre-existing disease of the veins of this leg.

CONCLUSIONS

If all patients with lower ureteral calculi were neglected, the great majority would recover unscathed. But a few would suffer more or less serious harm and this harm we wish to prevent.

Each case of ureteral calculus, therefore, presents the following questions: Is immediate operation desirable? If not, should manipulation be tried? If so, what method should be used? How long is it safe to temporize?

Each must be guided by his own experience, judgment, and skill. I have come to the conclusion that only the less drastic forms of manipulation are indicated. Patients with stones, the expulsion of which cannot be stimulated by the gentler measures, should be operated upon when and if the stones have been given a reasonable opportunity to be expelled. The time constituting a reasonable opportunity will be measured by the amount of disability caused by the pain, and by careful evaluation of the damage produced. I have seen a stone lodged in the lower ureter expelled after 6 months of careful observation. This stone caused in that time only 4 days of disability and no appreciable damage to the kidney. On the other hand, I am afraid that some patients treated by multiple manipulations have been subjected to more danger, have suffered more pain, and lost more time, than if they had been operated upon in the first place.

In all cases, whether operative or not, attempts to prevent recurrence should be made. Ureteral dilatation, pelvic irrigation, treatment of infection, attention to diet, fluid intake, and to changing urinary reaction will usually prevent recurrences.

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THE DEVELOPMENT OF PROSTATIC HYPERPLASIA

CLYDE L. DEMING M.D. Sc.D. F.A.C.S. New Haven, Connecticut

THE current views concerning the development of so called prostatic hypertrophy do not emanate from the urological field alone but from most of the fields of medicine. In spite of the many hypotheses very little actual progress has been made in the solution of this problem since Sir Everard Home so well described the enlarged prostate 140 years ago. The prostatic gland has a tendency to enlarge at the age of 50 years. Autopsies in men past 50 years corroborate this fact. Sixty-five per cent of men at 65 have some prostatic enlargement. Medicine and public health have done much to lengthen man's life span and since prostatic enlargement is a disease of elderly men we find that the lesion must of necessity become more common. Longevity then is the fertile field for the development of prostatic overgrowth and causes our problem to assume greater proportions than ever before.

What do we actually know about the development of "prostatic hypertrophy"? Very little. We do not have any actual knowledge of its causes. Experimental work in animals has produced a physiological hypertrophy but not a pathological enlargement comparable to the benign prostatic enlargement seen in man. We are inclined however to believe—but we do not have any positive data—that the lesion in man is due to an imbalance of male and female hormones in favor of the female hormone. Consequently scientists have proposed the treatment of the lesion by testicular hormone. Results of such treatment in this country and abroad produce grave doubts as to the value of this therapy beyond producing a temporary hypertonicity of muscles. In fact, a recent report by Heckel would definitely indicate detrimental effects from the use of this therapy by causing aspermatogenesis. To some individuals, even prostatics, this latter effect might be welcome. We have no means at present to prevent the development of "prostatic hypertrophy" except castration early in life and no control of its growth after it has once begun.

We know from our patients that the first symptom of prostatic overgrowth is usually

little frequency in urination. As the enlargement becomes more evident, increased frequency finally, complete obstruction to urination. In other individuals, complete obstruction to urination may occur dramatically and usually after coitus, ingestion of alcohol, or exposure to cold. The clinician can deduct fairly accurately that in the first group of patients, who gradual onset of symptoms, the growth of prostate involves the middle lobe while in the second group of patients, who have a bladder neck obstruction, the lateral lobes obstructing factor. The cystoscopist confirms these conclusions. The surgeon finds an overgrowth of tissue which is encapsulated, beneath the mucous membrane of the prostatic urethra and compresses the normal lateral lobes into a thin sheet of tissue. The mass of tissue removed at operation may represent one or two lobes, a median lobe and an occasional group of spheroids or single scattered spheroids, which themselves are encapsulated. The pathologist describes the surgical specimens as composed of tissue predominantly glandular but with variable amounts of muscle and fibrous tissue.

Since the clinician and pathologist have common terms and agree that the histology characteristic of adenoma, myoma or leiomyoma, we shall call the lesion a benign enlargement. One can also employ one more common fact. Prostatic enlargement is composed of three tissues, glandular, muscular and fibrous. Since the normal prostatic gland is composed of these three tissues, it is highly probable that the lesion develops from one or more of these primary component tissues.

It is the purpose of this paper to show and how "prostatic hypertrophy" develops and demonstrate that it is a neoplastic, hyperplastic rather than a hypertrophic lesion, and to present evidence in support of the hypothesis that it is derived from an embryologicalanlage. Animal experimentation has failed thus far to produce a histological lesion comparable to that seen in man. It seems at present that the only approach to this problem is the study of the lesion in its early phases.

During the past 5 years, the author has been making serial sections of prostates removed at autopsy. Prostates of normal size with no

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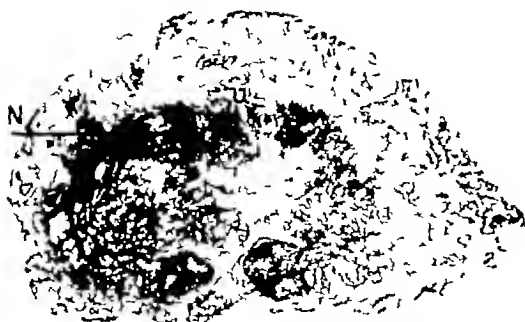


Fig 1 Histological section of prostate of man 58 years Showing minute fibromuscular nodule, *N*, in muscular wall of urethra, *U* No glandular hyperplasia $\times 16$

gross or microscopic lesions have been prepared for microscopic serial section study. In the normal prostate, the relative amounts of glandular tissue, muscular tissue, and fibrous tissue vary as to age. In the infant and the aged with an atrophic prostate, the proportion of glandular tissue is relatively small. After adolescence and during early adult life, glandular tissue is preponderant. After the age of 40 years, the glands in the lateral lobes become somewhat dilated and cystic. During the fifth, sixth, and seventh decades, the glands become less active, and their epithelium is definitely diminished in height. The relative amounts of glandular tissue vary also in different locations of the prostatic gland, including the prostatic urethra. At the bladder neck the muscular wall of the urethra is well developed and thick and is relatively free from glands and ducts. On the



Fig 3 Histological section of prostate of man 64 years Note numerous small, whitish areas in muscular wall below the floor of the urethra. These areas represent developing fibromuscular masses. The left muscular wall of the urethra shows two well developed, glandular nodules below which are many focal points of fibromuscular and glandular activity $\times 19$

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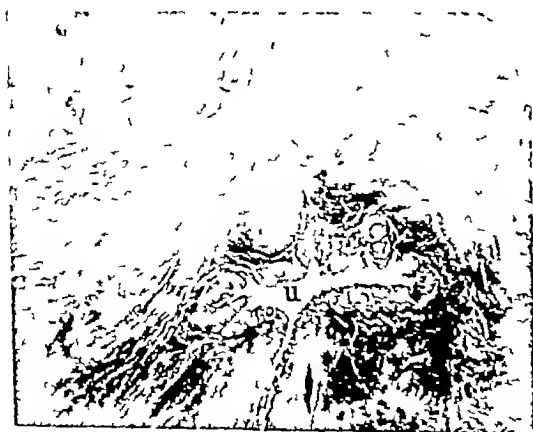


Fig 2 Photomicrograph of histological section of prostate of man 84 years Showing single fibromuscular nodule beneath mucous membrane of urethra, *U* No glandular hyperplasia



Fig 4 Histological section of prostate of man 60 years Showing fibromuscular and glandular nodules in the muscular wall of the urethra below the floor. *U* shows the urethra $\times 16$

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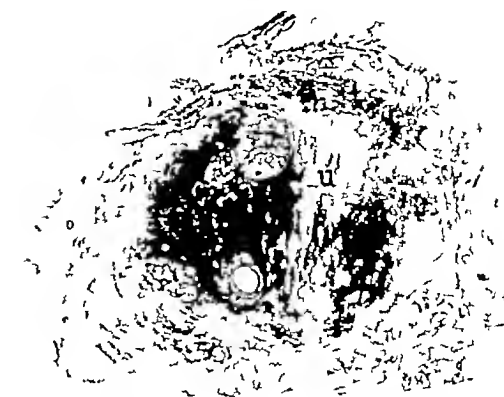


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Fig. 5 Histological section of prostate of man 68 years. Showing asymmetrical enlargement of lateral lobes in the muscular wall of the ureters. The right lobe is predominantly glandular but contains few residual fibromuscular nodules. The left lobe contains numerous small fibromuscular nodules. It is beginning glandular hyperplasia. *U* marks the urethra. $\times 5$.

was responsible. Marion believed that these glandular masses could develop from any glandular element of the prostatic gland.

The author wishes to produce evidence that the glandular theory of development is probably false. Velpen, in 1841; Thompson, in 1873; Kautsch in 1919, and Reichauer in 1934, recognized fibromuscular and glandular masses. There are over 30 cases of prostatism reported in the



Fig. 7 Histological section of prostatic urethra of man 70 years. Showing small fibromuscular nodule being invaded centrifugally. *U* marks the urethra, *V* the nodule. $\times 5$.

literature in which the enlargement was composed of constricted muscle and fibrous tissue. These masses involved 1 or all 3 lobes and have been described as "leiomyomas." Patch and Rhea found that 25.4 per cent of 181 consecutive surgical specimens of so called prostatic hypertrophy showed leiomyomatous nodules varying in size from 0.5 to 3 millimeters in diameter.

Our study of autopsy specimens of prostates from men over 45 years of age has shown, in addition to glandular masses, rounded, aglandular muscular masses close to the urethra. In the early phase, glandular masses never exist without the presence of muscular hyperplasia or fibromuscular masses. The aglandular or fibromuscular mass frequently occurs independently and without the presence of glandular hyperplasia. They however usually occur together. The more

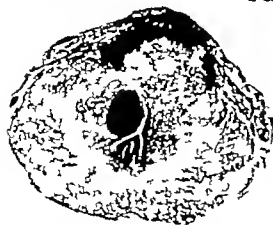


Fig. 6. Histological section of prostate of man 68 years. Showing fibromuscular nodule in lateral wall of urethra. The nodule is being invaded laterally by glands. $\times 9$.



Fig. 8 Section of specimen weighing 68 grams, of prostate of man 69. fibromuscular nodule adjacent urethra. Most of the tumor is glandular. *U* the urethra. $\times 11$.

we look for aglandular masses, the more frequently they are found. It is apparent that aglandular and glandular masses are formed early in the development of benign prostatic enlargement. What part, if any, do the aglandular masses play in the production of a full grown prostatic enlargement? What is their relation to the glandular masses? From what tissue or tissues do the aglandular and glandular masses arise?

From the study of thousands of serial sections of early lesions of the prostate and urethra, the author finds fibromuscular hyperplasia and aglandular nodules in the muscular wall of the posterior urethra. The aglandular or fibromuscular masses may be single but are more often multiple and bilateral, located anywhere within the musculature of the urethral wall between the external and internal sphincters. As many as 16 aglandular masses have been found at one level. They are more common near the verumontanum. They vary in length from 500 to 20,000 microns. As they develop in size, they tend to become cigar-shaped or oblong and later become encapsulated. As the result of localized outgrowths or of the union of two or more developing centers, they may assume a nodular appearance (Figs 1 and 2). The fibromuscular mass begins as a hyperplasia of fibromuscular tissue between the muscle fibers of the urethral wall but not in the true prostatic glandular substance *per se*. Again, it appears as hyperplastic fibrils around a tiny blood vessel but never around the prostatic ducts. As the fibromuscular mass increases in size, new blood vessels appear within it. Later its stroma becomes more compact, and the tissue at the periphery of the mass takes on a fibrous tissue capsule which is probably the result of compression (Fig 3).

The minute glandular nodules vary in size and are surrounded by circular fibers of fibromuscular tissue. The acini within a nodule may show active budding epithelial projections and dilated cystic areas. Cystic dilatations appear early, but corpora amylacea are not seen in the early lesions. Like the fibromuscular nodules, the glandular nodules are first seen in the muscular wall of the urethra and not in the true lateral and posterior lobes of the prostate. When these nodules increase in size, they deflect the urethra greatly, compress the true lateral and posterior lobes, and appear as lateral lobes on either side of the urethra. They do not develop from the sub-urethral glands of Albarran, as was formerly

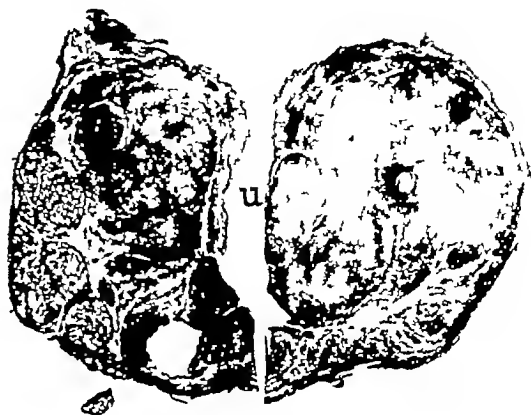


Fig 9 Histological section of surgical specimen of prostate of man 80 years. Showing mostly fibromuscular tissue with a few glands in the left lobe. U, marks the urethra. $\times 124$

thought, because these nodules are formed well within the muscular coat of the urethra (Figs 4 and 5).

The study of many nodules cut serially has led the author to conclude that the glandular nodule is a result of the invasion of an aglandular mass or nodule by epithelial buds from an adjacent duct. These epithelial buds may enter the solid fibromuscular tissue mass laterally or centripetally and form glands. One can readily demonstrate this epithelial response on the inside of a duct adjacent to an aglandular nodule while directly across its lumen the epithelium lies dormant. The growth of the fibromuscular tissue is apparently much slower than the growth of the glandular tissue. For this reason, the primary fibromuscular mass may be partially or entirely invaded by the more rapidly growing epithelial tissue, with the result that the full grown nodule appears glandular. As the peripheral muscle tissue becomes compressed, it forms the "surgical capsule" of the glandular mass which is seen in the surgical specimen (Figs 6 and 7).

Glandular nodules have not been found in the lateral and posterior lobes in the early stages of the development of so called prostatic hypertrophy. Aglandular nodules have been seen in the roof of the urethra and below the crista urethralis, from which anterior and middle lobes respectively could theoretically develop. Thus we have found the anatomical location for the development of the lobes seen clinically. While enlargement of any one or all of these lobes can be diagnosed clinically, cystoscopic and digital examinations do not tell us whether the enlarged lobes are glandular, aglandular, or a mixture of these tissues.

¹ Fibromuscular mass and aglandular nodule will be referred to as lesions which are histologically similar with the exception that the latter represents a later stage of development and is usually encapsulated.



Fig. Schematic drawing of dissemination of muscle fibers of muellerian duct in all of posterior urethra.

Thus far we have ascertained that the physical development of benign enlargement of the prostate passes through two phases: first, the formation of the fibromuscular nodule and second, the invasion of the primary fibromuscular nodule by epithelial tissue and the formation of glands which simulate normal prostatic glands. What are the forces behind these developments.

The evidence so far produced would indicate that the fibromuscular masses develop before there is any evidence of glandular hyperplasia, that they appear in the muscular wall of the urethra, and that they are most frequently located near the verumontanum and in the floor of the urethra. They are not found in the capsule, in the lateral lobes, or in the posterior lobe of the prostatic gland. The aglandular masses become infiltrated most rapidly near the verumontanum, where a larger number of ducts pierce the urethra. The aglandular nodules remain aglandular where there are not any ducts, or but few ducts, that is, close to the urethral mucous membrane and near the vesical neck. The study of surgical specimens cut serially corroborates this finding (Figs. 8 and 9). Occasionally one finds a prostatic specimen which contains small glandular masses without much hyperplasia of the fibromuscular stroma. The occurrence of such tumors may be explained on the basis that the early hyperplasia of the fibromuscular tissue causes such a rapid growth of the epithelial tissue that the glandular masses are formed before aglandular masses have time to develop. The early glandular masses appear in the same locations as the aglandular masses and not elsewhere. They are formed from hyperplastic ductal epithelium which has invaded the solid fibromuscular mass. It would seem that the glandular development is a secondary phase of hyperplastic prostatic growth and not a primary one and further that the hyperplastic fibromuscular tissue has inher-

ent qualities which stimulate epithelial growth and cause the epithelium to invade the less rapidly growing fibromuscular tissue.

This method of glandular tissue formation from ducts is similar to that seen in the normal embryological budding from the posterior urethra whose mucous membrane forms the anlage of the prostatic gland. This epithelial response may be a reawakening of the activity possessed by the ducts during the embryological development of the gland.

The primary fibromuscular nodule found in the development of so called prostatic hypertrophy closely resembles the uterine myoma in its appearance, muscle arrangement, and staining qualities. As we have stated before the fibromuscular nodules occur in greatest numbers near the verumontanum. The utrunculus masculinus is a homologue of the uterus and is derived embryologically from the Muellerian duct system. In their exhaustive study of the embryology of the prostate, Lowsey and Walker both state that the muscle fibers of the Muellerian duct system pierce the posterior urethra near the verumontanum and entwine themselves with the regular muscle fibers of the urethra (Fig. 2). Since the uterine myoma is derived from a muscle cell, may not the primary prostatic tumor also have its origin in one of the muscle cells of the lower Muellerian duct system? It seems fair to assume that the uterine myoma and the primary lesion of prostatic overgrowth have a common embryological anlage.

This hypothesis can be supported by two observations, one clinical and the other experimental. Clinically the surgeon not infrequently experiences a difficult suprapubic evocation because of adhesions in the posterior urethra. The pathologist, on examining these specimens, notes the incorporation of the verumontanum with the specimen. It is well known to the cytologist that these tumors grow some distance distally to the verumontanum. The experimental factor in this hypothesis is found in the response of the tissues of the posterior urethra to hormonal therapy. Van Wageningen, Jenkins, and others have noted a great thickening of the epithelium of the utricle in rats and monkeys after injection of the female hormone. The utricle contains the anlage, an anatomical structure such as is present in the uterus, where muscular fibers and glandular elements are extraordinarily sensitive to hormonal agents of the estrogenic series. It is reasonable then, to hypothesize that the primary nodule in the development of prostatic hypertrophy has for an anatomical basis the anlage of

the Muellerian duct system. The activating principle responsible for its growth may be some member of the estrogenic series.

For further evidence of the possible influence of estrogenic hormones on fibromuscular and glandular growth, one must make reference to the fibroadenomas of the breast. Here the periductal and periacinar fibromuscular element shows much hyperplastic activity. There is also a multiplication of the ducts and glands. Geschickter's work suggests that this lesion is one whose development may be due to an estrogenic factor. While the lesions of both the breast and the prostate are histologically benign, they are subject to malignant changes.

One should not be permitted to pass on in the face of these findings without reference to some of the older theories of the development of "prostatic hypertrophy." Guyon, Loeschke, Adrien, and Kausch, who are the main proponents of the arteriosclerotic theory, must admit that arteriosclerosis does not always occur in individuals who are suffering from benign enlargement of the prostate. It is equally true that many patients who have arteriosclerosis do not have any evidence of prostatic enlargement. Kausch's fanciful theory of arteriosclerotic involvement of the arteries of the outer glands of the prostatic urethra seems definitely disproved by this serial section study. Ciechanowski, Rothschild, Hirsch, and Greene and Brooks have favored an inflammatory theory. The infection, which is a frequent finding in cases of prostatic enlargement, produces a local fibrous tissue development which obstructs the ducts and glands and causes them to become dilated and enlarged. It is true that the serial study of many prostates shows round cell infiltration and some evidence of inflammation. It is likewise true that many sections of surgical specimens fail to show any changes due to inflammation. Cabot and Smith clearly demonstrate in the follow-up of men with histories of infection through middle life to the age of prostaticism that there is less likelihood of the development of so-called prostatic hypertrophy in this group as compared with a similar group of individuals who have never had prostatic infections. The functional and constitutional theories of the development of prostatic enlargement are interwoven with hormonal arguments, and we have not sufficient positive data to discuss them intelligently at this time. Further studies in embryology might give more positive evidence.

The neoplastic theory of enlargement of the prostate, although rejected by Ewing, has certain phases in its favor. The primary tumor resembles

the uterine myoma, which is neoplastic and probably has the same or similar structural origins. That a certain number, 12 to 20 per cent, of the surgical specimens removed for benign enlargement show malignant characters is a well recognized fact. The tissues which compose benign tumors of the prostate, both fibromuscular and glandular, are certainly not just enlargements of the existing elements but duplications by many times. The primary muscular elements invite epithelial hyperplasia and development of glands similar in appearance to the glands seen in the normal prostate. The term "hypertrophy of the prostate" should be applied only to physiological increase in size of the prostatic gland without multiplication of its components. It is evident from this study that benign enlargement of the prostate in elderly men is not hypertrophied tissue but hyperplastic tissue which has a tendency to develop from many focal points, to grow without limit, and ultimately to cause the death of the individual.

CONCLUSIONS

- 1 The early phases of benign prostatic overgrowth are found in the muscular walls of the posterior urethra in autopsy specimens.
- 2 The benign prostatic overgrowth usually passes through two phases of development.
- 3 The first phase is the development of a fibromuscular mass from the intramuscular stroma of the posterior urethra.
- 4 The second phase is the invasion of the fibromuscular nodule by the epithelium of a prostatic duct.
- 5 This epithelial proliferation develops prostatic glands and ducts of normal appearance.
- 6 The epithelial element overgrows the fibromuscular element so as to make the full grown lesion appear glandular.
- 7 The glands in the posterior urethra and prostate are not primarily involved.
- 8 The primary fibromuscular nodule resembles the fibromyoma of the uterus and may be derived from a remnant of the Muellerian duct musculature.
- 9 Benign overgrowth of the prostate is hyperplastic tissue, not hypertrophied tissue.

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PERIRENAL ABSCESS

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SUPPURATION in the fatty tissue surrounding the kidney is uncommon, especially when one considers the frequency of surgical lesions within the kidney. Because of the difficulty of diagnosis in the early stages and the fact that its pathology is still undetermined, perirenal abscess is of interest not only to the urologist but to all those interested in medicine.

Confusion concerning the nomenclature arises from the fact that perinephritic abscess has been referred to as primary, when it originates in the perinephritic tissue, or secondary, when it originates in the kidney or some other focus. Since there is much evidence to demonstrate that perirenal infection is secondary to infection in the kidney or in the surrounding organs or tissues, it would seem reasonable to regard all occurrences of perirenal abscess as secondary.

In classifying perirenal abscesses it seems logical to call all abscesses within the fascial envelope of the kidney, or Gerota's fascia which develop from a perinephritis, true perinephritic abscesses, whether they originate from an existing renal disease, such as pyonephrosis, nephrolithiasis or tuberculosis, or cortical metastatic renal infection, and all others which arise from infection of adjacent organs and tissues should be classed as false perinephritic abscesses, whether subdiaphragmatic, subphrenic, or psoas.

Metastatic infection of the perirenal fat without involvement of the kidney is conceivable as no portion of the body is exempt from such occurrence, and a few cases have been reported in which no evidence of renal infection was found. When abscess occurs in connection with pyonephrosis, lithiasis, or tuberculosis, the diagnosis is not difficult, as symptoms which point to infection in the urinary tract are usually not wanting. But in metastatic infection of the renal cortex diagnosis may be difficult and delayed, and often a perinephritic abscess is the only indication of renal infection.

It is conceded that septic emboli may find lodgment in the perirenal tissues just as in any other organ, yet the point has not been sufficiently supported by evidences found at operation or

autopsy to be convincing beyond doubt. The long period of time from the localization of the infection to the time when diagnosis is made gives opportunity for healing of small cortical abscesses which might not be found even at autopsy, and less likely at operation.

Hunt's finding of a renal source in over 50 per cent of his cases, in which an examination of the kidney was made during operation for perinephritic abscess, is significant. In operating for relief of perinephritic abscess, examination is frequently and properly omitted as being an imprudent procedure, which would only add to the dangers already present.

Cabot has called attention to the frequency and importance of coccic infection of the kidney, particularly in the milder cases. He believes that they are more common than is generally supposed, and are much more common than the septic infarct described by Brewer. Spontaneous healing in these mild cases of coccic renal infection may occur and probably often does occur. The reaction of the kidney under the circumstances probably depends upon several factors, i.e., number and virulence of bacteria, resistance of the tissues to the staphylococcic toxins, etc. In certain of these infections perinephritic abscess occurs. Trauma may play a part but probably it is not so much of a factor as it was thought to be by earlier writers. The frequency of unilateral as against bilateral occurrence may be due to some local condition, in one kidney a condition may exist which predisposes to infection, or, if the infection is bilateral, a local condition in 1 kidney may prevent its recovery.

The grouping of perirenal abscesses given by Fowler and Dorman is eminently satisfactory. (1) Those having origin in destructive lesions of the kidney, such as pyonephrosis, nephrolithiasis, tuberculosis, etc. (2) Metastatic abscesses in which there is a history of a remote focus of infection in boil, carbuncle, paronychia, respiratory infection, etc. Cases which arise from foci of lymphatic extension, as from pelvic disease, cannot be excluded but probably form an unimportant group. (3) Those rare cases caused by direct extension from suppuration in neighboring organs such as retrocecal abscess, subphrenic abscess, and empyema.

In the group secondary to existing renal disease

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urological study usually furnishes helpful diagnostic evidence. The metastatic group is of most concern because of the severity of symptoms and the difficulty of diagnosis. In the majority of cases the staphylococcus is the infecting organism.

The clinical picture of suppurative perinephritis is similar to that of acute renal infection. Since the perinephritic abscess originates as a rule in an acute cortical abscess of the kidney it is impossible to distinguish between the two in their earliest stages. But when the acute stage has passed, chronic perinephritic abscess differs markedly in its characteristics from chronic pyelonephritis. Often no pus appears in the urine, the function of the affected kidney is not much impaired, and the infecting organism may or may not be found by culture of the urine from the diseased kidney. The characteristic symptoms are pain, tenderness, fever of the septic type and palpable mass in the region of the kidney. Chill and fever usher in the attack. The pain is generally confined to the loin, dull aching in character and increased by movements of the body or flexion of the leg of the affected side. There may be nausea and vomiting with possible loss of weight. The patient often becomes profoundly septic. The tumor in the loin may be fluctuant and non-movable on respiration.

If drainage is delayed, the patient may die of sepsis or the abscess may become chronic and there is the possibility that spontaneous recovery may occur by rupture of the abscess through the skin or into one of the neighboring viscera or even by resorption of the pus.

Diagnosis is made usually on physical findings; the urological study is often negative, especially in the metastatic group of cases. The existence of kidney disease, such as atone, tuberculosis, or pyonephrosis, would direct suspicion toward a suppurative perinephritis in the presence of pain, costovertebral tenderness, and tumor. Urinalysis may or may not give positive evidence. It depends upon the time it is taken and the care exercised.

The following points are of value in diagnosis:

- (1) History of remote staphylococcal infection such as boil, carbuncle, paronychia, infected wound, and respiratory infection.
- (2) The clinical course of an obscure sepsis, high leucocytosis, picket fence type of fever.
- (3) The roentgenogram may show scoliosis with convexity of the spinal curvature toward the affected side, obscuration of the renal area and of the margin of the psoas muscle.
- (4) Costovertebral pain and tenderness.
- (5) Fullness or indefinite mass on palpation in the flank, which is immovable on respiration and rigidity of muscles.

Perirenal abscess should be diagnosed and drained as early as possible. In early cases suppuration within or without the fatty capsule of the kidney will show whether its origin is renal or not. But if the abscess is of long standing the primary effort should be simply to drain it and leave the treatment of other lesions for subsequent consideration. The necessity for nephrectomy is determined by the condition of the kidney. Usually it is wise to postpone nephrectomy until drainage has relieved the sepsis.

SUMMARY OF CASES

In the author's series of 34 cases of abscess in the perirenal space there were 20 males and 14 females. Their ages ranged from 10 to 65 years, the average was 36 years. Arranged according to decades 1 appeared in the first, 5 in the second, 9 in the third, 6 in the fourth, 5 in the fifth, 5 in the sixth, and 3 in the seventh decade.

The duration of symptoms before diagnosis varied from a few days to a year; the average duration was 6 weeks.

A history of possible predisposing disease was obtained in 25, including furunculosis, carbuncle, infected wound, appendicitis, tonsillitis, mastoiditis, influenza, leg ulcer, infected hemorrhoids, cholelithiasis, renal calculus, renal tuberculosis, and urinary infection. Seventeen involved the right side, 2 the left, and 3 were bilateral. In 3 the side involved was not recorded.

A history of previous urinary infection was obtained in 5 which varied from mild to severe, and included cystitis, pyelitis, lithiasis, pyonephrosis, and tuberculosis.

Fever was of the septic type in all. Likewise pain, variable tumor mass, and costovertebral tenderness were present in all patients. Leucocytosis varied from 7,600 to 31,000 and averaged 5,500. The hemoglobin was consistently low, the average was 65 per cent. The urine showed pus and albumin in variable amounts in 16 cases. Roentgenographic examination in 20 of the cases showed obscuration of the border of the psoas muscle in 6.

Of the 34 patients all were operated upon but 3 of whom died of sepsis. Autopsy in both instances showed the origin of the perirenal abscess to be carbuncle of the kidney. One patient not operated upon recovered spontaneously. Of those operated upon 22 recovered promptly after drainage, and 4 were nephrectomized later for calculus or tuberculous pyonephrosis. Seven died in the hospital either of sepsis or cardiac disease. Among these was a 65 year old male who died of sepsis. The autopsy showed multiple cortical abscesses.

of the kidney on the affected side. In the case of a 55 year old female a filling defect showed in the pyelogram of the affected kidney, in which a cortical abscess was found to be the cause of a perinephritic abscess. In a 55 year old male a renal calculus perforated the renal pelvis and was found in the perirenal abscess. Eighteen cases had definite evidences of renal disease in the form of pyonephrosis, lithiasis, tuberculosis, septic infarct, massive cortical abscess or carbuncle, and multiple parenchymal abscess. In 1 case the abscess followed injury to the loin. In 3 cases the abscess was an extension of a postcecal abscess. A 10 year old boy had an abscess beneath the sheath of the erector spinæ muscle, probably a metastatic infection from a recent mastoiditis.

The infecting organism was the staphylococcus in 18 cases, staphylococcus and streptococcus in 8 cases, and staphylococcus, streptococcus, and colon bacillus in 2 cases. In the remaining cases the type of organism was not recorded.

CONCLUSIONS

1. Perinephritic abscess of extrarenal origin in most cases is the result of blood-borne infection to the renal cortex followed by cortical abscess with extension to the perirenal tissues. The source of the infection is some remote focus such as carbuncle, boil, infected wound, or respiratory infection. Calculous disease and tuberculosis are the most common causes of perinephritic abscess of renal origin.

2. The infecting organism is usually one of the pyogenic coccus group.

3. The chief symptoms are pain and tumor in the loin, with costovertebral tenderness, fever of the septic type, and high leucocytosis.

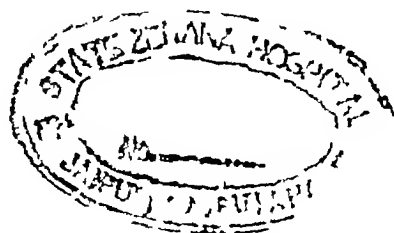
4. Diagnosis in the early stages is most difficult. Urological study is of value in the cases of primary renal disease, but in most of the metastatic cases positive urological evidence is lacking.

5. Roentgenograms may show a clouded renal area, obscuration of the border of the psoas muscle, and scoliosis.

6. Thorough drainage is emphasized. In the metastatic type simple drainage is usually followed by prompt recovery. In the type secondary to existing renal disease nephrotomy or nephrectomy may be required. Nephrectomy is usually postponed until drainage has relieved the patient of his sepsis.

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is a vastly important link in the sewerage disposal of the body, it is finely adapted to play its part of urinary reservoir, it intermittently empties itself, thus allowing undisturbed sleep and uninterrupted work, its lining cells resist secretion of urine, but if its function is disturbed or interrupted, serious results ensue

If these cancers grew on the surface of the body instead of in the bladder, cure would be comparatively simple. It is their position in the bladder which causes difficulties. These difficulties, however, should not be insurmountable with the most efficient of all instruments devised for the surgeon, the cystoscope, and with the various devices at our disposal for examination of the bladder, kidneys, and ureters. An accurate estimate of the changes in the bladder, ureters, or kidneys caused by the tumor should overcome many of the obstacles of the internal position of the tumor.

There are, as far as I know, only two methods of dealing with true bladder cancer. One is the wide surgical removal as practiced and published by the late Edwin Beer and Verne Hunt, and the other method involves various forms of irradiation. It is not within the province of this paper to discuss the former.

Irradiation comprises external irradiation by means of high voltage roentgenographic machines and irradiation directly applied to the tumor by means of radium. Because most bladder tumors are radio-insensitive, high voltage irradiation has been of little value to date in the treatment of bladder cancers.

When we know more about handling the 1,000,000 kilovolt machines, we may have a valuable aid in treating the worst type of bladder cancers, namely, the highly malignant and extensively infiltrating type. At the present time we are able to control by intrinsic irradiation only about 1 out of 4 of these cancers.

I have analyzed 2 recent reports of the high voltage treatment of bladder cancers, that of Wirth, of Seattle, who used an 800,000 kilovolt machine and that of Dresser and Rude, of Boston, who used a 1,000,000 kilovolt machine. Both report interesting and significant results and some control of infiltrating tumors. The latter noted that if the high voltage be used properly the general reactions of patients are less than with the 200,000 kilovolt machine. In all of these reports the controlled patients have been observed less than 3 years.

Dean and the author have reported on a patient with a large infiltrating bladder cancer, grade III, radioresistant, treated with the 800,000

kilovolt machine. We wrote as follows: "At present thirty months after admission patient looks and feels well. Gained thirty pounds, bladder looks normal. No rectal induration." Yet this patient died $3\frac{1}{2}$ years after first seen from extensive roentgenographic slough of the suprapubic region. Future work will be necessary to clarify the position of high voltage roentgenotherapy in the treatment of bladder cancer.

Radium treatment with all its disadvantages seems to me to be the most useful of all methods in the treatment of bladder tumors. It is flexible and can be used repeatedly through the cystoscope. When properly used suprapubically, the immediate operative mortality should be around 6 per cent, or about half that of surgical removal. The implantation of radon seeds into a cancer covering the ureters causes less disturbance to the kidney function than the operative removal and re-implantation of the ureter into the bladder. If total cystectomy be excluded, radium can cope with much more extensive tumors than can surgery.

SUMMARY OF 5 YEAR RADIUM RESULTS

Up to and including the year 1934, all private patients treated by radium have been included in this report. These cases, 228 in number, have not been selected but have been consecutive cases which represent a cross section of bladder cancer. If the tumor has been confined to the bladder, no matter what its size, an attempt has been made to control it by radium. Both the cystoscopic and suprapubic methods have been used.

In order to compute the percentage of 5-year cures these 228 cases have been divided into 2 classes, 40 indeterminate and 188 determinate cases. The latter were used only to compute the 5-year results. In the determinate cases there are 2 groups. There are 71 patients who proved to be cured of cancer for 5 years, the second group, or 117, are those who died of cancer or who were lost track of. In the indeterminate class, there were 14 patients not treated by radium but in whom some palliative operation had been necessary. Twenty-six patients in the indeterminate group with bladder cancer had been cured but died from some other disease or were lost track of before the 5-year period had elapsed.

Among the determinate cases 71 patients or 37.8 per cent were well for 5 years, 117 or 62.2 per cent died of cancer. Therefore, the percentage of 5-year cures is almost 38 per cent.

Of the 228 cases 90 patients or 39.4 per cent had papillary cancer and 138 or 60.6 per cent had infiltrating cancer. No specimen was obtained in

END RESULTS OF CARCINOMA OF THE BLADDER TREATED BY RADIUM

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ACCORDING to the 1937 report of the Division of Vital Statistics of the Bureau of the Census there were 144,774 deaths from cancer of which 4.65 or 3 per cent were due to cancer of the bladder. This percentage is about one-half of that of cancer of the prostate, or 7.59 per cent, and one-quarter of that of cancer of the breast which is 13.93 per cent.

The results from 4 cities have been tabulated and the percentages of all cases of cancer under treatment with primary cancer of the bladder are as follows: Atlanta, 1.9 per cent; Detroit, 3.6 per cent; Pittsburgh, 3.5 per cent; and Chicago, 4.1 per cent. These figures are for the calendar year of 1937.

At the present time there are no reliable estimates of the total number of all cancer cases in the United States; various estimates have been made, most of which range from 600,000 to 600,000 cases. If these estimates are at all correct and if the percentages quoted for the 4 cities hold true for the entire country, there would be from 15,000 to 30,000 cases of cancer of the bladder. This is a very rough estimate and cannot be regarded in any sense as an official statement.

Serious and persistent work in controlling bladder cancer began perhaps 25 years ago. The methods used have been widely divergent and only loosely standardized. The passing years have seen many advances, the most important of which seems to be the realization of the seriousness of the disease and the difficulties besetting its control.

The work of control has had one peculiarity. It has been periodically interrupted by confusing periods of interagency. Methods have been tried, found inadequate, discarded, and calmly returned to after a period of forgetfulness. Exact pathological classifications have been made, generally accepted, then discarded in part as imperfect, and brought to light and prominence years later. Mistaken treatments have been persisted in over

periods of years significant and perhaps important leads have been unearthed, then casually not followed and finally forgotten.

To be specific, Mendelbaum in a monograph from the Mt. Sinai Hospital accurately described, placed, and fixed various bladder tumors in their proper classification. This was done some 25 years ago. The main groups were then papilloma, papillary carcinoma, and infiltrating carcinoma. Most urologists have stumbled over the classification of a fourth group, the malignant papilloma or papilloma with typical cells. However, after a period of uncertain groping, urologists have simplified matters and placed these under papillary carcinoma. With rare exceptions they behave clinically like papillary carcinoma and he who considers them such plays safe. Yet at a recent meeting of the American Urological Association grave doubt was raised. It was suggested that these atypical papillomas were no more malignant than papilloma and might be treated like the latter, namely by fulguration.

Some years ago Counseiler and Brausch from The Mayo Clinic published the results of diathermy on 17 patients with inoperable and non-resectable bladder cancers. They got an astonishing 88 per cent 5 year cures. This has never been duplicated. The results, as far as I know, have not been checked and they have never been followed up.

N'ize, 35 years ago, established that papilloma could be controlled by the cystoscopic application of heat. Beer popularized this by the fulguration method. Neither Beer nor anyone else considered that the fulguration or heat method could be applied to bladder cancer with any hope of cure. Heat has long been discredited as a means of dealing with any cancer. We all remember the Percy cautery operation for cancer of the uterine cervix. Yet since the popularity of the transurethral operation for hypertrophied prostates, the transurethral instrument has been used widely in an attempt to destroy bladder cancers, and I think we will all be somewhat aghast to consider the 5 year results of this method.

The difficulty in successfully treating a cancer of an internal organ such as the bladder occasions these cycles of confusion and doubt. The bladder

These statistics are from a letter of Mr. Harold F. Davis, executive of the United States Public Health Service, from Memorial Hospital.

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 Hahnemann—Herbert P Leopold, Frank O Nagle, John
 A Brooke, Newlin F Paxson
 Jeanes—Roscoe W Teahan
 Jefferson—Thomas A Shallow, Louis H Clerf, Charles R
 Heed
 Jewish—Ralph Goldsmith, Philip F Williams
 Kensington—Edward A Schumann
 Lankenau—Gilson C Engel
 Memorial—Bruce L Fleming
 Methodist Episcopal—Calvin M Smyth, Jr, James B
 Mason
 Misericordia—Francesco Mogavero
 Mt Sinai—Benjamin Lipshutz
 Northeastern—T Turner Thomas
 Northern Liberties—Norman S Rothschild
 Pennsylvania—Walter E Lee, John B Flick, F R Robbins
 Philadelphia General—V W Murray Wright, Robert J
 Hunter, John C Howell, I S Hneleski
 Philadelphia Lyng In—Norris W Vaux
 Philadelphia Orthopedic—DeForest P Willard
 Presbyterian—John Paul North
 Preston Retreat—John Cooke Hirst
 Joseph Price Memorial—James W Kennedy
 Protestant Episcopal—Richard H Meade, Jr, Otto C
 Hirst, Andrew Knox
 St Christopher's—Harry E Knox
 St Joseph's—Verne G Burden
 St Luke's and Children's—Desiderio Roman
 St Mary's—James A Kelly
 St Vincent's—William F Morrison
 Shriner's—John R Moore
 Stetson—Robert S Alston
 Temple University—W Wayne Babcock, Walter I Lillie,
 Robert F Ridpath
 University of Pennsylvania—I S Ravdin, Harry P
 Schenck, Francis H Adler, Franklin L Payne
 U S Naval—F L Conklin
 West Jersey Homeopathic (Camden, N J)—E S Hal
 linger
 Wills—Warren S Reese
 Woman's—Margaret C Sturgis
 Woman's Medical College—Faith S Fetterman, James A
 Lehman
 Women's Homeopathic—Francis L Hughes

The Thirtieth Annual Clinical Congress
 of the American College of Surgeons
 Will Be Held in Chicago, October 21-25, 1940

CLINICAL CONGRESS TECHNICAL EXHIBITION

LEADING manufacturers of and dealers in surgical instruments, hospital apparatus and supplies, diagnostic and therapeutic apparatus, pharmaceuticals, and publishers of medical and surgical books were represented in the Technical Exhibition at the Bellevue Stratford Hotel in Philadelphia, October 16-20 1930.

W. D. Allison Co. Indianapolis
A. S. Aloe Co. St. Louis
American Cystoscope Makers, Inc., New York
American Hospital Supply Corp. Chicago
American Safety Razor Corp. Brooklyn
American Sterilizer Co., Erie, Pa.
D. Appleton-Century Co. New York
Armour & Co. Chicago
Austenal Laboratories, New York
C. R. Bard, Inc. New York
Bard-Parke Co., Davenport, Conn.
W. A. Baum Co., Inc., New York
Baxter Laboratories, Glenview, Ill.
Rudolph Beaver Inc., Waltham, Mass.
Becton, Dickinson & Co. Rutherford, N. J.
Burdick Corp. Milton, Wts.
S. H. Camp & Co., Jackson, Mich.
Wilcox Castle Co., Rochester, N. Y.
Gilbert Hyde Chick Co., Oakland, Calif.
Clay Adams Co. New York
Comper Manufacturing Co. Pittsfield, Mass.
Crane Co., Chicago
Crescent Surgical Sales Co. New York
Cervik Products, Inc., New York
Cutter Laboratories, Berkeley, Calif.
F. A. Davis Co., Philadelphia
Davis & Geck, Brooklyn
J. A. DeKontel & Son, Queens Village, N. Y.
DePuy Manufacturing Co. Warsaw, Ind.
Duke Laboratories, Stamford, Conn.
E. & J. Company, Philadelphia
Eastman Kodak Co., Rochester, N. Y.
Forrester Co., New York
General Electric X-Ray Corp., Chicago
Guelord Bros. Silk Co. Philadelphia
Hamilton Manufacturing Co. T. Rivers, Wis.
Fred Healey & Co., Brooklyn
Paul B. Hoeber Inc., New York
Hospital Liquids, Inc., New York

Hastington Laboratories, Hastings, Ind.
Johnson & Johnson, New Brunswick, N. J.
Jones Metalbalm Equipment Co. Chicago
Key-Sterner Corp., Long Island City, N. Y.
Lea & Febiger, Philadelphia
Charles Lewis & Sons, Philadelphia
Lewis Manufacturing Co. Walpole, Mass.
Liebel Flansberg Co. Cincinnati, Ohio
J. B. Lippincott Co., Philadelphia
MacGregor Instrument Co. Needham, Boston
Macmillan Co. New York
McKesson Apparatus Co. Toledo, Ohio
Medical Bureau, Chicago
Merck & Co., Rahway, N. J.
E. B. Meyrowitz Surgical Instruments Co. New York
C. V. Mosby Co. St. Louis
V. Mueller & Co. Chicago
New York Medical Exchange, New York
Ohio Chemical & Manufacturing Co. Cleveland
Operay Laboratories, Madison, Wis.
Pena Surgical Manufacturing Co. Philadelphia
Petrobagar Laboratories, Chicago
Physicians' Research Co. Chicago
George F. Pilling & Son Co., Philadelphia
Promethess Electric Corp. New York
Radiam Chemical Co. Inc., New York
Radiam Examination Corp., New York
Sanborn Co., Cambridge, Mass.
W. B. Saunders Co. Philadelphia
Scarsdale-Morris Co. Madison, Wts.
Sharp & Doherty, Philadelphia
J. R. Sieverdt Manufacturing Co. Kansas City, Mo.
Sklar Manufacturing Co. Brooklyn
Smith & Nephew, New York
C. M. Sorensen Co. Long Island City, N. Y.
E. R. Squibb & Sons, New York
Sterilized Unipole Corp. Brooklyn
Surgery, Gynecology and Obstetrics, Chicago
Ernest J. Sweetland, San Francisco
T. Yale Instrument Co., Rochester, N. Y.
Charles C. Thomas, Springfield, Ill.
Tower Co. Seattle, Wash.
Wallace & Tiernan Products, Inc., Belleville, N. J.
Westinghouse X-Ray Co. Long Island City, N. Y.
Wilson Rubber Co., Canton, Ohio
Winthrop Chemical Co., New York
Max Woelcher & Son Co., Cincinnati, Ohio
Williams & Williams (William Wood & Co.) Baltimore
Zimmer Manufacturing Co., Warsaw, Ind.

MARCELLO MALPIGHI (1628-1694) Supplied missing fact in Harvey's theory of the circulation of blood by discovery of channel of blood from artery to vein, founder of microscopical anatomy, persecuted and molested by men who had remained disciples of Galen, physician to Pope Innocent XII

SURGERY

GYNECOLOGY AND OBSTETRICS

An International Magazine, Published Monthly

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An Experimental Roentgenological Study in the Guinea Pig

R F BECKER, M S, W F WINDLE, M S, Ph D, E E BARTH, M D, and
M D SCHULZ, M D, Chicago, Illinois

THAT amniotic fluid may be swallowed by the fetus and that it may serve some nutritive function in the growth process during intra-uterine existence is not a new idea. Ever since Preyer's account in 1885, various investigators have discussed the possibility but, until recently, we have had very little experimental proof that swallowing of amniotic fluid is a normal physiological function of the fetus.

In his *Physiologie des Embryo*, Preyer wrote "That amniotic fluid is a food for the fetus is certain, but if it is not swallowed plentifully, it contributes little to nourishment beyond mere water feeding, a fact which follows from its slight specific gravity." Minot was essentially in agreement with Preyer in regarding the amniotic fluid as the chief water supply of the fetus. He summarized the work of Needham, Haller, Moriggia, Doederlein and others who pointed to the presence of epithelial cells, lanugo hair and vernix caseosa in the digestive tract as evidence indicative of the swallowing of amniotic fluid.

Other evidence in the past has come from various types of injection experiments. These have been largely indirect in that chemicals or dyes injected into the maternal blood stream were sought for in the amniotic fluid and in fetal tissues. Of late, direct injection into the amniotic cavity has been used. Preyer reported such experiments, but the object of them was to determine the source of amniotic fluid rather than to seek proof of fetal swallowing. Nevertheless, an analysis of some of these investigations (5, 8, 15, 23) seems to indicate that fetal swallowing occurred often.

In order to find out approximately how much the fetus urinated into the sac, Fehling administered sodium salicylate or potassium ferrocyanide twice daily to pregnant women near term. In 3 of 17 such cases, he found the potassium ferrocyanide in the amniotic fluid but the urea content of this fluid was less than 10 per cent. Furthermore, he was unable to pick up potassium ferrocyanide in the first urine passed by the newborn although it was present at the second urination in 3 cases. Sodium salicylate was readily obtained in the first urine of the child.

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From the Departments of Anatomy and Radiology, Northwestern University Medical School.
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Marcello Malpighi

1628 1694

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manner obtained the chemicals which were found in the urine of the newborn. It is not necessary to conclude that they were passed into the amniotic fluid as a product of fetal urination. Rather the salts could very well have arrived in the amniotic fluid by way of the placenta and fetal blood stream and diffused through the fetal membranes.

Zuntz (23) injected an aqueous solution of sodium indigosulphate into the jugular vein of pregnant rabbits. Very shortly thereafter the amniotic fluid became colored blue although no part of the fetus neither the kidneys nor the urine in the fetal bladder contained a trace of the dye. To make doubly sure that no dye passed into the amniotic sac via the fetus several fetuses were killed *in amnio* by injecting them with concentrated potassium hydroxide before the dye was introduced into the mother's vein. Again the same blue color appeared in the amniotic fluid. In similar experiments Wiener (15) demonstrated that only the maternal side of the placenta and the fetal membranes became colored by the injected material. The fetal placenta remained uncolored. Similarly Krusenberger consistently demonstrated the presence of potassium iodide in the amniotic fluid but only occasionally in the fetal kidney after administration by mouth to pregnant women near term.

In none of these experiments was injection made directly into the amniotic sac. One of the earliest direct injection experiments is that by Wiener (16) who endeavored to demonstrate functional resorption by the fetal intestine. He introduced a 5 to 10 per cent solution of calcium ferrocyanide into the amniotic cavity of rabbit and dog fetuses. Two to 3 hours later tests were made with ferric chloride and the chemical found in all the fetal tissues, especially the walls of the stomach, intestines, mesentery, kidney and skin. He thought the fetuses were swallowing actively and regularly and that absorption could have taken place by the stomach alone but possibly did also occur through the skin and surface of the umbilical cord.

In 1921 Wallock¹ demonstrated that coloidal dyes, such as trypan blue when injected during the latter part of pregnancy into the

amniotic cavity of guinea pig and cat fetuses, were absorbed by three routes through the gastro-intestinal tract by swallowing, by aspiration into the respiratory tract or by diffusion through the amnion.

If it has been difficult to make a case for fetal swallowing upon the evidence from indirect injection experiments, the answer to the question is still not entirely contained in the work of Wiener (16) and Wallocks. Both investigators employed a general anesthetic and performed laparotomies in which manipulation of the uterus and its contents is often unavoidable. Hence granting that swallowing did occur under such conditions, one is not justified in assuming that it is a normal physiological function of the fetus. We have discussed effects of anoxemia on fetal behavior elsewhere (18).

DeSnoo in 1937 described an ingenious treatment of polyhydramnion by apparently accelerating the swallowing of amniotic fluid. He reported having successfully treated several women by injecting 80 cubic centimeters or more of a saccharin solution of 50 tablet strength into the amniotic cavity after first withdrawing an equal volume of amniotic fluid. These injections directly through the abdominal wall of the mother were performed with little difficulty under local anesthesia. The girth of the maternal abdomen gradually decreased as did the distance from the symphysis pubis to the xiphoid process. Previous symptoms such as dyspnea and orthopnea disappeared and the fetus once again became palpable by ballottement. The infants delivered were normal in every respect. Saccharin was found in the blood of the umbilical cord and in the first urine of the child. DeSnoo attributed the reduction of polyhydramnion to an increased incidence of swallowing *in amnio* brought about by the presence of a sweet stimulus. In a single case in which no reduction followed such treatment an apparently normal child was delivered only to waste and die on the fifteenth day as a result of an atretic esophagus.

Using the same technique DeSnoo subsequently injected methylene blue into the amniotic cavity along with the saccharin. A per-

¹The description of ingestion of fluid *in amnio* see our earlier report.

manent catheter was inserted into the maternal bladder and urine samples were collected regularly. In this way any dye coloring the urine would give some indication of the rate and regularity of swallowing *in amnio*. The dye was readily absorbed in the fetal intestine, carried into the maternal blood through the placenta whence it was excreted by the mother's kidneys. The fetal membranes were found to be impermeable to the dye. The quantity of methylene blue excreted by the mother varied from time to time as the amount and concentration of the maternal urine varied. Sometimes it would appear early after injection, in other instances late. Off and on, no dye was found in a urine sample, only to appear again in a succeeding sample. It follows that the fetus did not drink regularly but only at intervals. When the women were questioned, there seemed to be a correlation between amount of fetal movement and strength of coloration of the urine. DeSnoo concluded that "apparently the child sleeps for many hours *in utero* and, becoming wakeful, it begins to move and to drink the sweet amniotic fluid."

Ehrhardt recently reported an interesting experiment. He injected 8 cubic centimeters of thorotrast into the amniotic sac of a woman 6 months pregnant. Fifteen hours later, after a hysterectomy, x-ray films of the fetal membranes and their contents revealed beyond any doubt that the thorium was concentrated in the stomach and small intestines. Ehrhardt was probably not aware that Menees and his co-workers had previously obtained similar but less striking results after replacement injections of strontium iodide in 21 human subjects. Some of their x-ray films indicated swallowing by the appearance of a stomach shadow. The strontium iodide was absorbed rapidly, decreasing in density in 4 to 5 hours.

From the foregoing studies, it becomes increasingly evident that the fetus normally swallows fluid *in amnio*. The use of a local anesthetic, if it altered conditions at all, probably did not upset the normal physiological balance *in utero* as much as would a general anesthetic. When laparotomy was avoided and replacement injections used, the effects of increased pressure in the sac were minimized. Hence the condition of the fetus in these later

experiments was probably nearly normal. From the standpoint of suitability of the injection mass, colloidal thorium dioxide is a better material than strontium iodide. It is believed to be practically inert physiologically¹ and is not absorbed in the intestinal tract. Since it casts a good shadow on the x-ray films, its passage can be followed easily at all times. Unfortunately the progress of the swallowed fluid was not observed over long periods of time by Ehrhardt and Menees. Nor has there been any attempt to discover just when swallowing and gastro-intestinal activity begins in fetal life. All the fetuses studied were near term except Ehrhardt's 1 case. In other words, there has been no genetic approach to the problem of the development of swallowing and gastro-intestinal motility *in amnio* by roentgenological methods. Studies in the past have approached the developmental problem in other ways but most of them were carried out under conditions of at least partial asphyxia, a fact which must be considered when applying the data to the state of visceral motility in the normal undisturbed fetus *in utero*.

In human fetuses, movement of the stomach musculature may be implied from the presence of amniotic constituents in the meconium as early as the fourth or fifth month. Several workers have observed gastric motility directly when the stomachs of mammalian fetuses were exposed. To what extent asphyxia induced by experimental procedures influenced these movements has not been determined.

Tani reported gastric movements in rabbit and human fetuses, and observed that adrenalin accelerated such activity in the rabbit but retarded it in the human. Friedman observed stomach motility in 58 millimeter cat fetuses. Windle and Bishop (19) noted spontaneous gastric movements in 35 millimeter cat fetuses (roughly comparable with the 12 week human). By 70 millimeters the behavior of the stomach appeared no different from that found in unanesthetized kittens a day or two old (120 to 140 mm). Rhythmical peristalsis began on the fundic side of the pyloric antrum and spread over the pylorus. Rapid emptying of the stomach into the duodenum was encountered

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Fig. Guinea pig \ forty-sixth day after copulation. One amniotic sac is outlined by 0.6 cubic centimeter of colloidal thorium hydroxide. Film taken immediately after injection and before swallowing by the fetus.

We have recently observed similar motility in late cat fetuses. The rapid passage from the stomach to the duodenum is all the more apparent if the fetus has swallowed air during delivery. The bubbles can be followed readily through the transparent gut wall. One of the present authors (W. F. W.) has occasionally seen regurgitation of the stomach contents during the last third of gestation in cat fetuses. It seemed to be accompanied by marked respiratory effort and probably was caused by respiratory compression of the abdominal contents. Using the balloon technique Carlson and Ginsburg recorded vigorous and frequent hunger contractions in 8 to 10 day prematurely delivered puppies.

Since Preyer's review of the subject in 1885 little has appeared in the literature concerning fetal intestinal motility. In 1907 Yarnse (21)

reported experiments on human and guinea pig fetuses. He observed intestinal peristalsis in specimens freshly killed for which reason limited significance may be placed upon his developmental account. He reported peristalsis first on about the twenty-sixth or twenty-seventh day (19 mm.) in guinea pigs. This was correlated with the first appearance of the longitudinal muscular layer and its nervous elements. Before this time (15 mm.) only circular muscle had been laid down, and only local constriction of the gut could be elicited by pinching or by faradic stimulation. Furthermore he claimed that until the eighth week (about 90 mm.) peristalsis was observed only when the fetus was immersed in a bath of Locke's solution at 38 degrees C. After 8 weeks movements could be seen upon opening the guinea pig's abdomen in the air.

In the human subject, he was unable to observe peristalsis until the eleventh week though the longitudinal smooth muscle and its nerves had been present since the seventh week. During the sixth week, when only the circular layer was present he elicited local contraction with a faradic stimulus. He believed that the early intestinal movements were of neurogenic origin.

Windle and Bishop (19) decerebrated pregnant cats by the anemia method and delivered their fetuses with placental circulation intact into a constant temperature bath of Locke's solution. They were able to induce local constriction of the intestinal wall in a few as small as 18.5 millimeters. Spontaneous movements appeared in 35 millimeter specimens, and the strength of peristalsis increased rapidly up to the 70 millimeter stage at which point in development intestinal activity resembled that of the newborn kitten. The movements caused segmentation and propagation of intestinal contents. It is important to note that even under experimental procedures in which an effort was made to preserve physiological conditions like those which obtain *in utero* all of the fetuses exhibited some *anoxemia*. Even under optimum conditions, blood gas analyses indicated an oxygen content in the umbilical vein of not more than 6.5 volumes per cent (about 50 per cent saturation). When this dropped to 2 volumes per cent intestinal

All ages calculated from time of vaginal menses began. Some births did not take place at this interval until the seventh second day. Anoxemia probably failed to occur on the first days the menses began.



Fig 2 The same pig, forty seventh day Some of the amniotic fluid has been swallowed, the thorium hydroxide can be seen in the fetal stomach (arrow)



Fig 3 The same pig, forty eighth day The material now fills the stomach and has passed along into the small intestine

activity diminished. When placental circulation was completely interrupted, muscle tonus diminished and writhing, pendulous movements replaced peristalsis.

Concerning defecation *in amnio* we have only our own observations to report. Although active peristalsis was commonly seen in the large bowel of experimentally delivered cat fetuses, the act of defecation was never observed while the intestines were exposed. When the animals were anesthetized before examining their fetuses, it was common to find large amounts of meconium in the amniotic sac. We have observed the passage of meconium into the sac in a few instances while delivering fetuses by cesarean section. Meconium is passed in the human at or shortly after delivery but the amniotic fluid does not contain it as a rule. After prolonged, difficult labor or in asphyxia neonatorum, meconium may be found in the bag of waters. We shall demonstrate that defecation does occur normally during the intra-uterine life of the guinea pig.

MATERIAL AND METHOD

Following Ehrhardt's technique we injected the amniotic sacs of 50 fetuses of 39 guinea pigs at various stages of gestation ranging from 37 days to term. In our colony, the average period of gestation ran about 66 or 67 days. The pregnant animals were fastened, back down, to an operating board and the position of the fetal head determined by palpation. Without using any anesthetic, a thin (No. 27) hypodermic needle was passed through the abdominal and uterine walls into the amniotic sac. On a few occasions no amniotic fluid was withdrawn, but usually a replacement injection was made with 0.4 to 1.0 cubic centimeter colloidal thorium hydroxide or dioxide (thorad or thorotrast¹). Injections were made as near the mouth as possible. After injection, roentgenograms were taken within a few minutes, a few hours, and then at daily intervals until birth.

¹We wish to acknowledge our indebtedness to the General Electric X-Ray Corporation and the Heyden Chemical Company who generously supplied us with these experimental materials.



Fig. 4. The same pig, fifty-third day. So much amniotic fluid has been swallowed that the sac is nearly clear. Material is concentrated in the stomach and intestines.



Fig. 5. The same pig, fifty-fourth day. The amniotic sac is clearer, the stomach nearly empty and the material is concentrated in intestines, segmentations may be seen.

RESULTS

With practice the chances of missing the amniotic sac during injection are small. Of the 50 injections attempted, only 6 were unsuccessful and these occurred during the earlier experiments. Positive swallowing and passage of the thorium through the gastrointestinal canal occurred in 31 fetuses. There were 4 others in which swallowing was doubtful, questionable stomach shadows appearing only after several days. Six fetuses aspirated the fluid into the lungs after the mothers had been intentionally subjected to anoxemia (17) but there was no passage into the gastrointestinal tract. Three young fetuses (37 to 38 days) retained thorotrast in their amniotic sacs but failed to swallow it any time during a 5 day observation period. In fact fetuses injected before the forty-first day either were not observed to swallow the thorium at all or did not do so until the forty-third day. The earliest incidence of fetal swallowing as determined by the presence of thorium in the

stomach was on the forty-second day, 24 hours after injection into the amniotic sac.

As will be seen in Table I the fetuses which were studied may be grouped conveniently into three age brackets: those running approximately through the forties, those through the fifties, and those through the sixties in terms of days of gestation. Column 1 lists the serial number of the pig. The symbol

A after any number indicates that the pig was subjected to anoxemia immediately after the first film was taken. By anoxemia is meant either rebreathing or breathing atmosphere with high carbon dioxide or nitrogen content. At the time we were interested in discovering the effects of anoxemia upon aspiration of amniotic fluid (17). Since all but 6 of the fetuses of guinea pigs so treated swallowed amniotic fluid they are included with normal specimens in this study. The effect of anoxemia upon gastrointestinal activity will be discussed later. Column 2 of Table I indicates the age of the fetus at the time of injection.



Fig 6 The same pig, fifty seventh day. The intestines are now filled and show the presence of many segmentations. This condition was maintained until the sixty first day.



Fig 7 The same pig, sixty first day, a m. Defecation in amnio has occurred (compare the intestines with Fig 6) and the meconium is mixing with the amniotic fluid to cause the sac to be outlined again.

Column 3 gives its age at the time thorium was first seen in the stomach, and following this the number of hours which had been required for the thorium to reach the stomach. It was not always possible to be sure just when this occurred unless many films were taken, but one can come reasonably close by exposing films immediately after injection and 2, 4, 6, and 12 hours later. Near term, it was essential to expose a film at least as soon as one-half hour after injection. In some cases, e.g. pig No. 14, the table reads "before 4," indicating evidence that swallowing had occurred well before the 4 hour film, for not only was the stomach outlined but also the small intestine. The rapidity with which thorium reached the stomach after injection increased with age. As Table II shows this took about 36 hours in fetuses 39 to 46 days old, about 11 hours in fetuses 50 to 59 days old, and from 1.8 to 3 hours in those 60 to 68 days old. However, there were individual variations.

It becomes apparent from inspection of Tables I and II that the speed at which thorium passed to the small intestine likewise increases with age. The average passage times in the three age groups were 127.2, 37.3, and 16.4 hours, respectively. Table II indicates that the material reached the large intestine much earlier in fetuses near term than it did in the youngest age range. Accompanying this increase in rate of passage through the gastro-intestinal tract, the time required to swallow the entire fluid contents of the sac decreased with age. We determined the time taken to swallow all the thorium by noting the interval required for the sac to become clear after the first faint stomach shadow had appeared. Quite often by the time we obtained a roentgenogram showing a clear amniotic sac the stomach shadow had disappeared too, leaving the intestines full of thorium. These data are recorded in Tables I and II.



Fig. 3. The same pig, sixty first day p.c. The fetus has begun to reswallow the fluid of the amniotic sac and shadow cast again be seen in the stomach (arrow)

Late in fetal life, usually not before the sixtieth day defecation occurred normally in *amnio*. Not only did the fetus defecate into the sac but it subsequently reswallowed the thorium impregnated meconium and repeated the process several times. An examination of the films revealed that as the amniotic fluid was absorbed in the intestines the thorium remained behind in a dense mass and the sac gradually became very clear. When defecation occurred a pool of the opaque material accumulated in the sac near the fetal anus and plaques of thorium could be found adhering once more to the sides of the sac. As this material mixed again with fresh amniotic fluid the sac became cloudy and opaque. Reswallowing was marked by the reappearance of a stomach shadow. In specimens whose progress we were able to watch for any length of time the entire cycle of swallowing defecation and meconophagy was repeated as many as five times before birth occurred. In Table I we have indicated by plus signs the number of

times defecation and reswallowing occurred in any fetus.

We have thought it best to illustrate fetal swallowing intestinal peristalsis, defecation and meconophagy in 10 selected films from a single fetus (pig No. 21). We were able to follow this animal for a period of 27 days and to observe its normal birth. During that time the fetus engaged in all of these activities. Evidence equally as convincing was found in the roentgenograms of each of the fetuses listed in Table I although not in every instance was it possible to observe the entire sequence of events. Figures 1 to 10 show the course of a small quantity (0.6 c.cm.) of colloidal thorium hydroxide through the gastrointestinal tract of this one fetus.

The fetuses ranging in age from 60 to 68 days may be divided into 2 groups. In one the mothers were subjected to anoxemia in the other they were untreated. Table III shows a comparison of these two groups in order to examine the experimentally produced effects of anoxemia upon the rate of swallowing the entire contents of the sac and upon the rate of passage through the gastro-intestinal canal. It appeared that under conditions of anoxemia the fetus swallows amniotic fluid faster than normally the sac emptying in 23 hours as compared to a normal rate of about 23 hours. On the other hand, the rate of passage of material to the stomach small intestine and large intestine seems to be a little though perhaps not significantly slower in the case of the fetuses subjected to anoxemia. Of course the number of observations upon which this table is based is rather small and the time intervals are at the best only approximate.

ANALYSIS OF RESULTS

It would seem from these experiments that swallowing of amniotic fluid begins normally around the forty second day in the fetal guinea pig. In specimens between 35 and 40 days old, swallowing has not been observed. The injection material remains in the amniotic sac of fetuses this young until at least the forty second day before it is swallowed. Why swallowing begins at this time and does not occur earlier especially when Yanase (21) found that peristalsis is possible on the twenty-sixth



FIGURE 1. The guinea pig fetus at day 45 of gestation. The bladder is grossly enlarged.



FIGURE 2. The guinea pig fetus at day 46 of gestation. The bladder is grossly enlarged (feathery in appearance). The stomach is grossly free of air.

or twenty-eventh day in the guinea pig is a matter of conjecture at present. Certainly Varney's data tell us little about what actually takes place in the normal fetus *in utero* and because he studied freshly killed material he looked upon intestinal motility under conditions of extreme asphyxia. It is even possible in fetuses as small as his that he mistook the writhing movements occurring near death (19) for true peristaltic movements.

On the other hand, it is interesting to speculate upon this question of the advent of swallowing *in amnio*. Perhaps we may look upon it as the beginning of an important nutritional function in fetal life—at least from the standpoint of water balance. As Reynolds has shown in the rabbit, partly from an analysis of Hammond's data, the volume of fetal fluids reaches a peak at about the twenty-fourth day of fetal life and then drops off rapidly until birth on the thirty-second day. At the time the curve for fetal fluids begins to drop precipitously, the fetal growth curve is rising

rapidly. Concurrently, placental growth rate and efficiency are on the decline. Such a picture suggests that the fetus begins to take some of the water it needs for metabolism from the amniotic fluid at this point, and that as it grows it draws more and more upon this source, perhaps continuing to swallow the fluid almost as fast as it is formed until birth. A similar condition is encountered in the chick where Yrbitch found that swallowing begins about the tenth day of incubation. At present we do not have adequate data in the guinea pig to allow us to draw accurate comparisons with the rabbit. This much is certain from the fetal growth curves of the guinea pig presented by Draper and Ibsen: fetal growth is increasing rapidly about the forty-fifth day of prenatal life, which is about the time we find swallowing. Both of these investigators have attempted to study the growth curve for amniotic fluid. Draper's data show an increasing quantity up to the forty-fifth day, after which the free fluid is variable but in many instances



Fig. 8 The same pig, sixty first day p.m. The fetus has begun to reswallow the fluid of the amniotic sac and shadow can again be seen in the stomach (arrow)

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TABLE II—EFFECT OF AGE UPON TIME REQUIRED TO SWALLOW ENTIRE CONTENTS OF AMNIOTIC SAC AND FOR THE THORIUM TO REACH STOMACH AND SMALL AND LARGE INTESTINE *

Age range in days	No. of cases	Average time in hour to swallow content of sac	No. of cases	Average time in hour for thorium to reach stomach	No. of cases	Average time in hour to reach small intestine	No. of cases	Average time in hour to reach large intestine
19 to 41	3	100.0	3	17.4	3	42.2	3	141.0
42 to 59	5	66.0	5	10	5	33.3	5	53.3
60 to 68	8	18.0	15	15.6 to 15.8*	1	10.3	13	21.0

*This table includes only those cases wherein there is little doubt about the time relationships involved.

* Including one atypical experiment in which 6 hours were required.

TABLE III—POSSIBLE EFFECT OF ANOXEMIA UPON RATE OF SWALLOWING THE ENTIRE SAC CONTENTS AND UPON RATE OF PASSAGE THROUGH GASTROINTESTINAL TRACT *

Age range in days	No. of cases	Average time in hours to swallow content of sac	No. of cases	Average time in hour to reach stomach	No. of cases	Average time in hour to reach small intestine	No. of cases	Average time in hour to reach large intestine
Untreated 60 to 68	4	21	6	10	5	13.5	5	21.0
Anoxemia 61 to 63	4	11	8	10	5	10	5	20

*This table includes only those cases wherein there is little doubt about the time relationships involved.

swallowing amniotic contents. This is occurring at a time when the fetus is growing most rapidly.

Not all the results produced by experimental anoxemia are conclusive because the analysis has been based on few cases. However, it appears that swallowing of fluid is enhanced. Other fetal activities, and especially rhythmical movements, are increased in the early stages of anoxemia (18). It should be noted also that only under such conditions did aspiration into the fetal lungs occur (17). On the other hand our data merely suggest that intestinal motility is diminished after anoxemia. Windle and Bishop (19) found a general fall in smooth muscle tonus and peristaltic activity in cat fetuses when the placental exchange was interrupted and asphyxia set up.

It should be kept in mind that no anesthesia was used in this present study, laparotomies were avoided, and in all but a few cases an equal volume of amniotic fluid was withdrawn from the sac before the colloidal thorium, itself physiologically almost inert, was injected. Since no more than 1 cubic centimeter of thorium was introduced at any time, normal pressure was not markedly altered even

in those few specimens from which no fluid was withdrawn. Therefore, we believe that the results obtained represent the true behavior of the fetal gastro-intestinal tract of the guinea pig *in amnio*. DeSnoo has already pointed to the practical significance of the technique employed in this study from the therapeutic standpoint.

CONCLUSIONS

1 Under normal physiological conditions *in utero*, the guinea pig fetus begins to swallow amniotic fluid about the forty-second day of gestation. This fact is indicated by the presence of a stomach shadow in roentgenograms after the amniotic sac has been injected with 0.4 to 1.0 cubic centimeter of colloidal thorium hydroxide or dioxide (thorad or thorotrast).

2 The rapidity with which the thorium reaches the fetal stomach after injection increases with age, taking about 36 hours in fetuses about 42 days old, and from 18 to 3 hours in fetuses near term (66 to 67 days).

3 The efficiency with which the material is propagated along the gastro-intestinal tract likewise increases with age.

TABLE I—SUMMARY OF ALL DATA

Gestation, day	Age of fetus at parturition	Therms in stomach		Therms in small intestine		Hours required to evacuate all thermes	Defecation	Rumination	No. micturitions	No. days interval
		Age in days	Hours after parturition	Hours after parturition	Hours after parturition					
124	20		95	19	103	—	—	—		1
128		23	84	103			—	—		
		44					—	—		
129		44			109	21	+++	+++	13	20
	26	47		10	66	104	+++++	++++	10	27
				26	70	64	+++	++		
141		11	81			58	—			
144		11	84			—	+	+		
	27	27	1				+	+	20	
1	20	20		54			+++	+++	14	
	20	20		60			—	—		
	60	60		70						
27	60	60		73						
26			120	120	25	26	+	+		
171			20	20		—	—			
			20	20		—	—			
173	30	30				28	—			
181	31	31			32	124	+	+		
184				1			+	+		
187				1			—			
191				1						
			121		122	122				
191				12		14	+	++		
			1				+			6
25	34	34	11	117		17	—			
25, 260	34	34		12		20	—			
250 (4)	34	34								
260 (4)			30							
266	36	36		20						
268	36	36		20						
268	37	37					—			
34	35	35	1		7				3	

Two or three fetuses reported in page Nos. 17, 20, 22, and 220.

Pat. No. 14—Reported same fetus on forty-eighth day.

Page No. 6—Reported same fetus on forty-ninth day.

(Before)

strikingly diminished. More information is needed on this point, however. We also need to know more about the conditions of fluid exchange in the placenta during this period of fetal development.

It would appear from the present results that between the fortieth day of gestation and birth there is a marked increase in the effi-

ciency of the fetal gastro-intestinal tract. The ability to propagate its contents improves rapidly from the fortieth to the fiftieth day. From then on improvement is more gradual until birth. With better intestinal propagation there is an increase in the rate at which amniotic fluid is being utilized if we may judge from the concomitant increase in rate of

MALIGNANT CHANGES IN FIBRO-ADENOMA OF THE MAMMARY GLAND

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IT is unquestioned fact that the better results achieved more recently in surgery of the mammary gland have been due not only to a refinement of surgical technique but also to a sharpened pathological diagnostic acumen. Recognition and demonstration by the pathologist that a significant number of fibro-adenomas of the breast may undergo malignant change have contributed to the increasing number of satisfactory results obtained in the operative treatment of mammary cancer. Surgical intervention is many times more effective for those patients in whom the lesion is localized to the mammary gland than for those in whom it has involved the regional lymph nodes. Furthermore, it is well known that certain localized tumors which present physical signs suggestive of malignancy do not show the histological changes of the same, while, conversely, carcinoma and sarcoma occasionally arise in a pre-existing tumor without causing symptoms and signs indicative of such a transformation. It is in the latter group of cases that the pathologist plays an important rôle in that he must find and recognize such changes. However, all fibro-adenomas should be removed, not only to rule out actual malignancy, but to forestall malignant deviation.

Although fibro-adenomas are usually considered under the pathological grouping of connective tissue neoplasia of the breast, they always contain a decided amount of epithelium in their structure. The various types of fibro-epithelial neoplasms are

1 Those having origin from the subepithelial tissue and giving rise to the intracanalicular variety

Abridgment of portion of thesis submitted by Dr. Miller to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery.

From the Division of Surgery, the Mayo Clinic and the Mayo Foundation.

2 Those arising as a localized neoplasia of the pericanalicular and periacinar connective tissue. The amount of epithelium in such tumors may be considerable.

3 A combination of the two preceding forms may exist.

4 Fetal fibro-adenoma, as described by Ewing, presents several structures of the fetal breast, "including very cellular connective tissue, alveoli without membrana propria, and imperfect differentiation between ducts and acini." The cellular overgrowth may be pronounced and suggest malignant deviation.

The word "cystadenoma," used to designate a fibro-adenoma which contains an intracystic papilloma as part of its structure, is a misleading term, for no reference is made to the fibro-adenomatous origin. The ducts may become obstructed, cyst formation may occur, and the ductal epithelium may undergo hyperplasia. Formation of papillomas and perhaps subsequent malignant change may also then occur.

The sudden enlargement of a previously existent fibro-adenoma must always be viewed with suspicion. Malignant deviation of such tumors may be in either of two directions since two types of tissue are fundamentally present. The occurrence of carcinoma in these tumors is somewhat rare, but the transformation of the connective tissue into sarcoma is more frequent. Both types of malignancy often promise an excellent result to proper surgical treatment, for the carcinoma or sarcoma may be confined to the adenofibroma giving it origin.

CARCINOMA IN ADENOFIBROMA

The frequency of adenofibroma undergoing carcinomatous change is unknown for (1) detailed reports are few in number, (2) it is quite difficult at times to differentiate histologically between benign and malignant

4. The speed at which all the thorium is flushed out of the amniotic sac and into the gastro-intestinal tract increases progressively with age.

5. Late in fetal life usually not before the sixteenth day defecation begins to occur *in utero* as a normal phenomenon. Meconio-phagy is also a normal physiological function of guinea pigs *in utero*. The cycle of swallowing, defecation and reswallowing of the thorium impregnated meconium may be repeated several times before birth.

6. It has been suggested but proof is lacking that the swallowing of the amniotic fluid is important from the standpoint of prenatal water metabolism. It may be significant that swallowing begins when the fetus is just starting to grow at its most rapid rate. Comparison with conditions in the rabbit suggests the probability that at this point the efficiency of the fluid exchange from the placenta via the blood stream is declining and that the fetus makes use of its reserve of fluid in the amniotic sac.

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axillary lymph nodes were enlarged. The results of roentgenographic study of the chest were normal. Radical amputation of the left breast was done and examination of the specimen (Fig. 2) revealed a grade I adenocarcinoma in an intracanalicular fibroadenoma (Fig. 3). The axillary lymph nodes were not involved. The patient had a smooth convalescence and has remained well subsequently.

SARCOMA IN ADENOFIBROMA

General recognition has been accorded the fact that a large number of sarcomas of the breast perhaps more than has been generally realized arise in pre-existing fibro-adenoma. Deaver and McFarland stated that in a total of 838 sarcomas, 193 were adenocarcinoma, as they termed the mesodermal malignant lesions superimposed upon fibro-adenoma. Previously, S. W. Gross had reported that 33 per cent of 156 cases were 'adenoid' in character.

This fact may be interestingly correlated with results obtained from animal experimentation. Heiman, in studying benign neoplasms of the breast of the rat found that after 26 successive transplantations of a spontaneous fibro-adenoma the tumor had suddenly become sarcomatous. Such an observation is also important in view of published reports of slowly growing human breast tumors suddenly changing their nature and assuming clinical and morphological attributes of a sarcoma. This fact and experiences such as that of Stark, in which after successive incomplete removals of an adenofibroma, the recurrences were progressively more cellular, may correspond in a degree to the changes effected in animal transplantation.

The enormous tumors of this category are those in which the epithelial elements have remained active, and in which dilatation of the ducts and acini has resulted in cystic formations of varying size. Usually, the history given by a patient with such a neoplasm is that a mass has been present in the breast for a long period, perhaps years, and that it suddenly has increased in size. Such neoplasms are irregular, nodular, and lobulated and are frequently complicated by hemorrhage, necrosis, and ulceration. From its initiation, the growth has a tendency to be somewhat circumscribed, and although it may become large, it still retains this character-



Fig. 3. Grade I adenocarcinoma in an intracanalicular fibroadenoma. X26

istic. In addition, it may be freely movable upon the chest wall.

CASE 2. Many of these points are well illustrated by a 43 year old white, married woman who had noted a small mass in her left breast for 6 years. 1 or 6 months before admission the tumor had grown rapidly. Occasional sharp pain upon palpation was noted in the breast, but the patient had not noticed either bleeding from, or retraction of, the nipple. She had lost 20 pounds in weight in the 3 months before coming to the Mayo Clinic. The results of general physical examination were considered to be normal save for a large nodular, irregular mass in her left breast. Although the neoplasm was attached to the skin, the latter was unbroken, the nipple was not retracted and the growth was freely movable upon the deeper structures. Enlargement of the left axillary lymph nodes was thought to be present. Roentgenologically, the pulmonary fields were normal.

Pathological investigation, after operation, revealed a grade I adenofibrosarcoma with myxomatous change, arising on the basis of an intracanalicular adenofibroma (Figs. 4 and 5). The patient has subsequently remained well.

When local removal is performed, recurrence is a marked feature. This may be due to an incomplete removal, for even in an apparently well circumscribed tumor, malignant cells frequently extend into the perivascular spaces beyond the capsule. In addition, malignant change may also take place in other fibro-adenomas of the same breast. Twelve recurrences were present in the case reported by Hoffman.

Many types of tissue may be found in such tumors. This wide diversity was realized

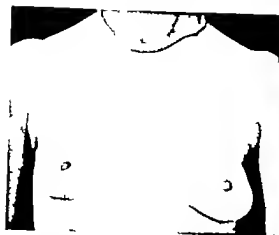


Fig. Malignant lesion in left breast.



Fig. Operative specimen.

tumors, and (3) a highly varied terminology is in use. In reviewing the literature 34 such lesions were found, and in addition, Ewing reported that he had encountered several moderately malignant carcinomas which appeared to have been derived from fibroadenomas. The usual history reveals that a slowly growing neoplasm of fibro-epithelial structure had existed for some years and eventually grew much more rapidly with the onset of malignant changes. In such cases the grade of malignancy has been moderate.

A review has been made of 15 patients having fibro-adenoma of the breast in which carcinomatous changes had taken place. The entire group is female. The youngest patient was 31 years old and the oldest 69; the average age was 46 years. Although the relationship between civil state and malignancy is unknown, all of the patients were or had been married. A family history of malignancy was obtained in but 3 cases. Practically an equal distribution as to the side affected was noted, the right mammary gland being involved eight times and the left, seven. In 6 of 10 patients from whom definite information could be obtained, it was learned that a tumor had been present in the breast previously for periods varying from 2 to 40 years, while 4 of this group stated that they had noted recent growth of the mass. A history of trauma to the breast was noted in but 1 case, while 2 patients reported a loss of weight and

6 suffered from pain in the breast. The tumor was attached to the skin in 6 patients, and the nipple was retracted in 2.

The great majority of these neoplasms are of a low grade of malignancy. Upon a pathological basis of I to IV, 8 specimens were grade I, 4 grade II, 2 grade III, and in 1 consisting of 2 separate nodules in the same breast, grade II was present in one mass and grade III in the other. Involvement of an axillary lymph node by carcinoma was found only in the 2 lesions of grade III character.

Of these 15 patients, 1 has never been traced after her original dismissal. Eight of the group followed to the present are living and well. Five patients have died since operation, but only 2 of these 5 had a recurrence. The remaining patient in this group who had a grade I lesion had been well for 9 years when last heard from. An analysis of these statistics reveals that 9 of this group have up to the time of their investigation lived for 5 or more years since operation.

CASE. For emphasis and illustration, the history and clinical findings of one patient in this group will be detailed. A 37-year-old white woman stated upon admission that she had noted mass in her left breast for 3 years. For the past year it had been increasing in size. A history of trauma or pain in the breast or of loss of weight as not obtained. Physical findings are essentially normal except for an irregular and fairly hard tumor measuring 5 by 3 centimeters which filled the left breast (Fig. 1). Some axillary lymph nodes seemed to be present and the

axillary lymph nodes were enlarged. The results of roentgenographic study of the chest were normal. Radical amputation of the left breast was done and examination of the specimen (Fig. 2) revealed a grade I adenocarcinoma in an intracanalicular fibro-adenoma (Fig. 3). The axillary lymph nodes were not involved. The patient had a smooth convalescence and has remained well subsequently.

SARCOMA IN ADENOFIBROMA

General recognition has been accorded the fact that a large number of sarcomas of the breast, perhaps more than has been generally realized, arise in pre-existing fibro-adenoma. Deaver and McFarland stated that in a total of 838 sarcomas, 193 were adenosarcoma, as they termed the mesodermal malignant lesions superimposed upon fibro-adenoma. Previously, S. W. Gross had reported that 33 per cent of 156 cases were "adenoid" in character.

This fact may be interestingly correlated with results obtained from animal experimentation. Heiman, in studying benign neoplasms of the breast of the rat, found that after 26 successive transplantations of a spontaneous fibro-adenoma, the tumor had suddenly become sarcomatous. Such an observation is also important in view of published reports of slowly growing human breast tumors suddenly changing their nature and assuming clinical and morphological attributes of a sarcoma. This fact and experiences such as that of Stark, in which after successive incomplete removals of an adenofibroma, the recurrences were progressively more cellular, may correspond in a degree to the changes effected in animal transplantation.

The enormous tumors of this category are those in which the epithelial elements have remained active, and in which dilatation of the ducts and acini has resulted in cystic formations of varying size. Usually, the history given by a patient with such a neoplasm is that a mass has been present in the breast for a long period, perhaps years, and that it suddenly has increased in size. Such neoplasms are irregular, nodular, and lobulated and are frequently complicated by hemorrhage, necrosis, and ulceration. From its initiation, the growth has a tendency to be somewhat circumscribed, and although it may become large, it still retains this character-



Fig. 3. Grade I adenocarcinoma in an intracanalicular fibro-adenoma. $\times 26$.

istic. In addition it may be freely movable upon the chest wall.

CASE 2. Many of these points are well illustrated by a 43 year old white, married woman who had noted a small mass in her left breast for 6 years. 1 or 6 months before admission the tumor had grown rapidly. Occasional sharp pain upon palpation was noted in the breast, but the patient had not noticed either bleeding from, or retraction of, the nipple. She had lost 20 pounds in weight in the 3 months before coming to the Mayo Clinic. The results of general physical examination were considered to be normal save for a large, nodular, irregular mass in her left breast. Although the neoplasm was attached to the skin, the latter was unbroken, the nipple was not retracted, and the growth was freely movable upon the deeper structures. Enlargement of the left axillary lymph nodes was thought to be present. Roentgenologically, the pulmonary fields were normal.

Pathological investigation, after operation, revealed a grade I adenosarcoma with sarcomatous change, arising on the basis of an intracanalicular adenofibroma (Figs. 4 and 5). The patient has subsequently remained well.

When local removal is performed, recurrence is a marked feature. This may be due to an incomplete removal, for even in an apparently well circumscribed tumor, malignant cells frequently extend into the perivascular spaces beyond the capsule. In addition, malignant change may also take place in other fibro-adenomas of the same breast. Twelve recurrences were present in the case reported by Hoffman.

Many types of tissue may be found in such tumors. This wide diversity was realized



Fig. 4. Grade I adenofibrosarcoma: fibrous stromatous changes. $\times 33$.



Fig. 5. Enlargement of areas in section shown in Figure 4. $\times 33$.

about a century ago by Sir Astley Cooper for he stated then that all the changes which occur in other tissues may also be seen in the breast and that in addition, it has some of its own. The presence of cartilage and bone has always been of interest, and in 1937 Raso was able to collect 74 cases and add 1 of his own in which these tissues were present. Historically it is interesting to note that perhaps the first description of such a tumor was given by Morgagni.

CASE 3. An adenochondrosarcoma was found in a 49 year old married, white woman who had noted a nodule in her right breast for 8 years before coming to the Mayo Clinic. The mass had grown slowly for 7 years and then it had begun to enlarge rapidly. Slight pain in the breast had been noted for 6 to 8 months, but of late it had been so severe that the organ had to be supported constantly. Ulceration of the breast or enlarged axillary or supraclavicular lymph nodes had not been noted by the patient. Cough and weight loss had not been present and she considered her general health good.

The results of physical examination were normal save for a slightly elevated blood pressure and a semicircular mass in the right breast. This was 10 to 15 centimeters in diameter and the overlying skin was tense, shiny and discolored. The axillary lymph nodes were not enlarged and the results of roentgenographic examination of the chest were normal. Radical amputation as performed and the operative note was that the patient had a huge tumor involving the entire breast, the skin being glossy and inflamed. Marked edema of the lower half of the mammary gland was present and redness of the skin extended to the chest wall above. The microscopic report of the tissue examined was that a cystic degenerating grade II adenochondrosarcoma

sarcoma that had developed on an intracanalicular fibromyxadenoma was present. The lymph nodes were uninvolved. The patient received a course of roentgen therapy after dismissal from the hospital and has since remained well.

Of the cases of adenofibrosarcoma encountered in this study (24) all but 1 were seen at the Mayo Clinic before operation had been performed on the breast. Of these 23 cases, which may be designated as a primary group the following statements may be made. Twenty two of the patients were women. Their ages ranged from 33 to 62 years, the average being 47 years. Five of these individuals reported that other members of their family had had malignant disease and 14 of the group had noted that a tumor had been present in the mammary gland for periods varying from 2 to 32 years. Only one patient reported trauma to the affected breast and only 4 had lost weight. It is of some significance that 15 patients had experienced some type of pain in the affected breast for pain is not usually present in the early stages of a malignant lesion. Interesting findings in the physical examination were a change in color in the overlying skin in 8, attachment of the tumor to the skin in 10, free mobility of the underlying structures in all. Clinically the axillary lymph nodes were enlarged in 5 and the supraclavicular in 1. The thorax was normal in all patients subjected to x ray study.

As in carcinoma arising from adenofibroma, the majority of the sarcomas were of low

pathological grade Eleven were grade I, 8, grade II, 3, grade III, and but 1, grade IV Several of these specimens contained tumor giant cells, this group comprised 3 of the grade II neoplasms, all 3 of the grade III, and 1 of the grade IV Involvement of the axillary lymph nodes was not present in any of the cases

Of the total of 23 patients, a complete follow-up was obtained in 17, and of the latter 10 are living and well Of 7 patients definitely known to be dead, 4 died of unknown causes, 2 of unrelated conditions, and only 1 of a recurrence Incomplete end-results were present in 3 patients and their present condition is unknown Three of the patients have never been contacted since their postoperative dismissal

The results of operation in this group as a whole have been favorable We find that up to the time of investigation, 14 have lived at least 5 or more years This favorable experience is in complete accord with the pathological grade of these lesions

SUMMARY

Patients in whom malignant changes have occurred in adenofibroma have been studied Of these, 15 had carcinoma while 24 had sarcoma

It has again been demonstrated that adenofibroma does not always remain a benign

fibro-epithelial tumor If a mass is present in the breast and a presumptive diagnosis of "adenofibroma" has been made, it should be removed, if possible, to exclude plain malignancy or an adenofibroma in which malignant change has taken place

Nine of the carcinomatous and 14 of the sarcomatous patients survived 5 years or more These comparatively high figures are in complete accord with the low pathological grade of the lesions of both types

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MANAGEMENT OF BREECH DELIVERY

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THE occurrence of breech presentation as a problem in the management of labor at term may be handled in one of three ways. The obstetrician may convert the breech to a vertex by the maneuver of external version; he may deliver the infant as a breech through the pelvis or he may elect to perform cesarean section.

External version, when feasible, may be a very beneficial procedure. If successful, it converts a dangerous presentation to one which is distinctly less dangerous, thereby reducing the expected risk to the infant seven to tenfold. On the other hand it can never be expected to render breech delivery with its attendant problems and risks entirely obsolete, not only because the correct diagnosis of position is often not established until labor is advanced, but also because attempted version may either be unsuccessful or may if successfully completed be followed by a return of the fetus to its original position *in utero*. Consequently a discussion of breech delivery whether through the pelvis or through the abdomen, can never be considered *ana*chronistic.

Since the rationale of any method of treatment should be supported by the results obtained from its use, the management of breech delivery as here presented is based upon experience with the problem during 50 years in one institution, the Boston Lying-in Hospital. It is hoped that in the near future figures will be available for a survey of all breech deliveries in both house and out patient service during the entire history of the institution. For the moment only a half century of hospital deliveries have been surveyed.

Figure 1 is a graphic representation of average fetal mortality occurring on the hospital service from 1888 through 1937. The white portions of the columns represent the figures for general fetal mortality regardless

of presentation position, or method of delivery; the whole columns represent the figures for mortality among breech-born infants. All deliveries are reflected, including abortions, miscarriages, stillbirths, and neonatal deaths from any cause whatsoever.

These gross figures must be modified considerably before the corrected mortality rate in breech delivery can be ascertained. In 1936 the writer published his standards for computing corrected fetal mortality (4) and called attention to the fact that until similar standards are used by investigators of this problem the comparison of results obtained in various clinics is of very limited value. For better or worse the standards recommended in 1936 will be used in this discussion.

When one thinks of the risk of breech delivery one usually considers it in relation to the obstetric hazards to which a normal living child presenting by the breech is subjected in the process of being born. This risk must be selected from the gross figures above reported before the rationale of management can be discussed intelligently.

Table I shows the process by which corrected figures are obtained. First of all, only cases uncomplicated by conditions which are dangerous or lethal to the infant are selected. "Complicated" cases, in which the gravid woman is afflicted with toxemia, eclampsia, nephritis, diabetes, cardiac disease, syphilis, hydramnios, and certain other pathological conditions, are excluded. One can hardly say that a stillbirth or neonatal death occurring in association with labor in an eclamptic, diabetic, or syphilitic woman is necessarily due to the factor of breech presentation alone, nor can one claim entire credit for the management of breech delivery in securing the birth of a live baby in such a case. The same thing is true when the process of gestation or labor is complicated by placenta previa or ablatio placentae, since the actual delivery can neither take unqualified credit for a favorable outcome nor entire responsibility for

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stillbirth or neonatal death. In other words, such complicating conditions as have been mentioned require that the risk to the breech born infant of the woman suffering, for example, from eclampsia or placenta previa be compared only with the risk to any infant born under similar circumstances

One complication of labor deserves especial consideration. In our series of mature breech deliveries, otherwise uncomplicated, frank prolapse of the cord occurred in 3.4 per cent of the cases. While it is true that, strictly speaking, the risk to the infant in the breech labor in which the cord prolapses should be compared with the risk to any other infant born following prolapse of the cord, the finding of a seven-fold greater frequency in our breech series than among deliveries at large indicates an appreciable increment of increased risk from this complication when the breech presents. Furthermore there is considerable evidence that occult prolapse or pressure on the cord intrapartum is present in numerous cases, as will be later discussed. For this reason, in Tables I and III the effect of prolapse of the cord upon the prognosis for the infant is shown in its influence upon the fatality rate.

The second and third categories to be excluded in computing the corrected mortality are those cases in which macerated or grossly malformed infants are delivered. The reason for this requires no explanation.

Limiting consideration, therefore, to the group of pregnancies and labors uncomplicated as previously defined, a final factor must be considered, that is, the weight of the delivered infant in relation to its gestational maturity. It is obviously inaccurate to point with pride to the successful outcome of the delivery of a premature infant weighing 1,500 grams or 3 pounds 5 ounces, and to count it as a favorable case in statistical computation if one is to exclude from the series the death from "prematurity" of another fetus of the same birth-weight. In this table, therefore, the premature infants, weighing less than 5 pounds, are segregated in one category, the immatures, weighing 5 pounds but less than 6, are placed in another. Our experience indicates that only 74.3 per cent of breech infants

TABLE I—DELIVERIES OF BREECH PRESENTATIONS AT THE BOSTON LYING-IN HOSPITAL FROM 1888 THROUGH 1937

	Cases	Deliveries	Well	Still-born or died	Mortality per cent
A Breech deliveries	2,035				
1 Uncomplicated	1,459				
a. Premature		222	99	122	55.2
b Immature		178	162	16	8.9
c Mature		1,060	963	97	9.1
d Mature including 37 cases with frank prolapse of cord		1,097	988	109	9.9
2 Complicated—including all cases with frank prolapse of cord	453				
3 Non viable—macerated and malformed	123				
B Cesarean sections	58				
1 Uncomplicated		52	49	3	5.7
2 Complicated	6				

weigh 6 pounds or more, 10.9 per cent 5 to 6 pounds, and 14.7 per cent less than 5 pounds (4). Since the prognosis for the premature or immature infant is compounded of the weight at birth, the method of delivery, the anesthetic used, if any, and the postnatal care, no attempt will be made at this juncture to discuss these two categories, our corrected figures deal only with mature infants weighing 6 pounds or over at birth.

Having in this fashion limited the problem to the management of the patient at or near term with a primary breech presentation, the next points to be considered are:

1 Is abdominal delivery indicated? If so, why?

2 What should the management of the case be if pelvic delivery is decided upon?

While routine cesarean section is frequently used for primiparous breech delivery, especially by surgically and non-obstetrically trained consultants, this procedure is radical, to say the least. Newell, in 1931, stated, "If the breech is not in the pelvis at the beginning of labor, and if the baby is unusually large, or if the pelvis is contracted, cesarean section may be properly considered, but the indication is not so much the breech presentation as the other factors in the case,

TABLE II.—INDICATIONS FOR CESAREAN SECTION IN BREACH DELIVERY

Primiparas	Multiparas
1. Ankylosis, left hip	1. One or more previous stillbirths or neonatal deaths following pelvic delivery
2. Cephalopelvic disproportion, estimated by clinical and x-ray measurements	2. One or more previous cesarean sections
3. Elderly primiparity (37, 38, 4, 42, 43, 44)	3. "Small conjugate plus previous craniotomy for hydrocephalic breech
4. Estimated large infant (all over 9 pounds)	4. Obstructing dermoid cyst.
5. Pelvis contracted	5. Aortopelvic hemorrhage in woman aged 44
6. Rupture of membranes, long-standing, without labor	
7. Tuberculosis, active	
—	—
32	20
All mothers well. One infant died eleventh day of erysipelas.	All mothers well. One infant died of hydrocephalus, one of impetigo on the twelfth-fifth day

such as disproportion between the child and the pelvis, early rupture of the membranes, and unsatisfactory dilatation of the cervix. In multiparas cesarean section is practically never indicated for breech presentations *per se* in the absence of other indications.

It would be a pleasure if it were possible to be able to state that the problem of fetopelvic disproportion could be reduced to a mathematical formula. We have long been accustomed to measure maternal pelvis by means of callipers and by digital exploration and have succeeded in identifying a few of them as being so contracted in one diameter or another as to render the birth of a living child through the natural passages quite impossible. The vast majority fortunately are large enough to allow spontaneous delivery as attested both by measurement and by clinical experience. There remain, none the less, a group of cases in which the pelvis is of the borderline type, in which a test of labor may be resorted to before section is decided upon. This procedure, valuable as it is when we are dealing with vertex presentations, is of little value when the breech presents, because the aftercoming head has no chance to become molded by the forces of labor. There is no

opportunity for a second guess after the head has come into relationship with the maternal pelvis, for if the original judgment has been faulty the infant is sure to be stillborn or fatally traumatized.

The work of Caldwell and his associates, at Sloane, and that of Thoms, at New Haven, have given us a changing concept of the architecture of the female pelvis and its effect upon the mechanisms of labor and of pelvic delivery. They have directed attention to the midpelvic planes, and are able, by somewhat different methods of approach, to quantitate the diameters of the pelvis at its various levels. Most of their published work, however deals logically enough, with the problem of vertex labor in association with the various types of pelvis which they have described. One important point is still unanswered. Can x-ray studies predict the ability of the aftercoming head to pass through the maternal pelvis?

Herein lies the crux of the problems of cephalopelvic relationship in breech presentation. The ideal mathematical formula would answer this by indicating that the infant's head unmolded would pass through the pelvic inlet, the interspinous plane, and the pelvic outlet. Before this can be derived some method of measurement of the infant's head, preferably of the essential biparietal diameter must be available.

In the autumn of 1931 the task of measuring by x ray the heads of breech infants *in utero* was undertaken by the writer in conjunction with Dr. Stewart H. Clifford, who was interested in the problem of determining the occipitofrontal diameter in relation to the maturity of the infant and eventually to the predictable birth weight. The crossed-wire or crossed-thread technique of stereocentrometry was used and the measurements recorded were compared with the caliper measurements of the infant's heads at birth. Clifford's series, which was much larger than the breech series due to the enormously greater incidence of vertex presentations, yielded results which were much more encouraging for his purposes than did the smaller number of measurements of the head in the fundus. The latter showed that an

accurately measurable diameter of the head could be demonstrated in 65 per cent of the cases investigated by x-rays, whereas the balance were unmeasurable, taking, however, the measurable cases as a group, 89 per cent of them yielded a satisfactory occipitofrontal silhouette, 8 per cent a biparietal shadow, and 3 per cent an oblique plane from which neither the occipitofrontal nor the biparietal diameter could be read or calculated

These findings, while of value, are nevertheless at best an approximation. Summarized in another way they indicate that there is only a 5 per cent chance by this method of securing the important biparietal reading direct at the first observation, and a 58 per cent chance of measuring the occipitofrontal diameter, from which the biparietal diameter can be predicted only within certain limits. It is undoubtedly more accurate than the mere laying on of hands but falls far short of the ideal quantitative method.

Finally, the method of stereoroentgenometry shows the weakness of all stereoscopic observations, namely, the personal equation. Stereoscopy is essentially qualitative rather than quantitative and is only of value to the individual who possesses binocular vision. Stereoroentgenometry is not a method susceptible of being recorded for all to see, as are the x-ray measurements of Thoms, its interpretation, either by projections into space by crossed-threads or by the precision stereoscope, is subject to the personal equation of the observer.

Table II summarizes the cesarean sections done for uncomplicated breech presentation at the Boston Lying-in Hospital. The first section in a multipara with this condition was done in 1899, the first in a primipara in 1911. The table shows that among 32 primiparous sections, 18, or over half, were done for varying degrees of estimated fetopelvic disproportion, 6, or almost one-fifth, for elderly primiparity, and 4, or one-eighth, for presumably large infants. All the mothers survived. One infant died on the eleventh day postpartum of erysipelas. The two commonest indications for section in the 20 multiparous cases were either one or more previous sections, or previous catastrophes in connec-

TABLE III—MORTALITY IN BREECH DELIVERY, MATURE INFANTS, BEFORE AND AFTER MARCH 1, 1921

	Deliveries	Well	Still born and died	Inter-curent	Mechanical	Mortality per cent
Single pregnancies						
1888—March 1, 1921	387	330	57	11	46	14.7
March 1, 1921—1937	599	504	35	7	28	5.8
	986	894	92	18	74	9.5
Single and multiple pregnancies						
1888—March 1, 1921	427	366	61	12	49	14.3
*March 1, 1921—1937	633	597	36	7	29	5.6
	1060	963	97	19	78	9.1
*Additional mortality when cases of frank prolapse of the cord are added						
1888—March 1, 1921	448	381	67	14	53	14.9
March 1, 1921—1937	649	607	42	8	34	6.4
	1097	988	109	22	87	9.9

tion with pelvic delivery. All of these mothers survived. Two infants were lost, one from impetigo on the twenty-fifth day, and one from hydrocephalus, had the mother been roentgenographed before section in this case and in one other in the series in which a hydrocephalic child was born, it is likely that the 2 cases would not have been subjected to abdominal delivery.

Since there were 500 mature primiparous breech deliveries through the pelvis during these 50 years, as against 32 cesareans, abdominal delivery was resorted to in 6 per cent of the primiparas. Among the 500 pelvic deliveries 5 infants lost their lives because of misjudgment of fetopelvic relationship. This experience seems to indicate that 7 per cent of primiparous breeches at term should be delivered by section. Adding the 20 multiparous breech cesarean sections to the 560 multiparous pelvic deliveries the incidence of abdominal delivery was 3.4 per cent. Since 6 infants among 560 were lost by reason of disproportion the incidence of section might better have been 4.6 per cent.

As regards pelvic delivery of the breech infant, it may well be admitted that the nature of the presentation and the mechanism of labor are such as to enhance the risks of birth to an appreciable degree. In our clinic from

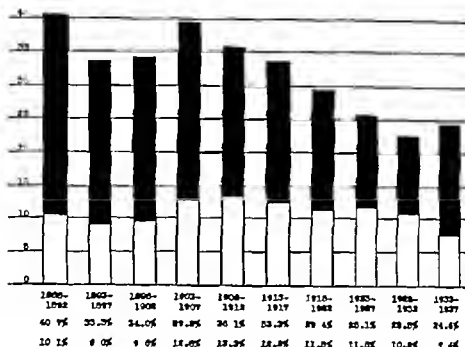


Fig. Gross fetal mortality in all deliveries (white segments) contrasted with gross fetal mortality in breech deliveries (whole columns)

1913 to 1935 it was shown that the corrected mortality rate for mature breech born infants was 6.9 per cent, as contrasted with a corrected mortality rate on the service at large of 0.7 per cent, indicating a tenfold risk from the presentation *per se* (4).

It is generally taught that the conduct of labor when the breech presents should be conservative. The patient should be kept in bed during the first stage in order to prevent, if possible, early rupture of the membranes. During the second stage the accoucheur should be scrubbed and prepared to assist delivery if delay should occur after the infant is born to the umbilicus otherwise only if the condition of mother or infant should render interference imperative.

Some clinicians do not agree with this method of management. DeNormandie writing in 1914 gives a hint of this when he states "The author believes that all breech cases at the final expulsive stage should be under complete anesthesia. I have too often seen physicians try to deliver the arms and after coming head in cases without ether and then

hurriedly and cruelly clap on the ether cone expecting to obtain in a few seconds complete relaxation. No one knows when an arm will be extended and never can the best intelligent suprapubic pressure be given with the patient straining at the utmost with her abdominal muscles." In 1926 Irving and Goethals advocated elimination of the second stage in breech delivery by extraction at full dilatation. Piper and Bachman in 1929 and Dorsett in 1931 have advocated essentially the same procedure. Schwartz, 1932 states that complete and footling breeches should be delivered at complete dilatation, whereas frank breeches are allowed to deliver spontaneously if continuous progress occurs.

These authorities are cited as evidence of an appreciable minority who believe that certain dangers to the fetus in conservative breech delivery may be avoided by a more active policy. These are briefly the risk of compression of the cord during the second stage of labor a risk which should be ascertainable if constant watch of the fetal heart is kept the risk of sudden intrapartum separation of

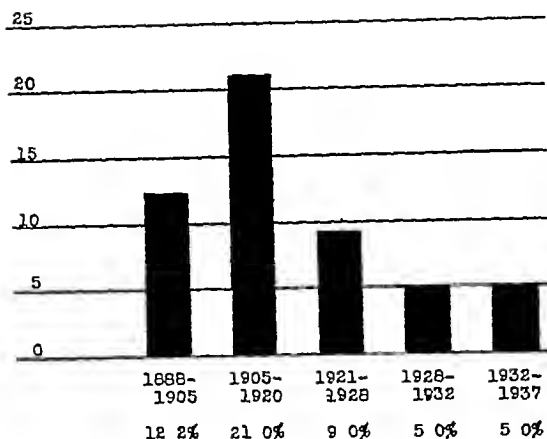


Fig 2 Mortality in primiparous breech delivery of 482 mature single infants, 1888 to 1937

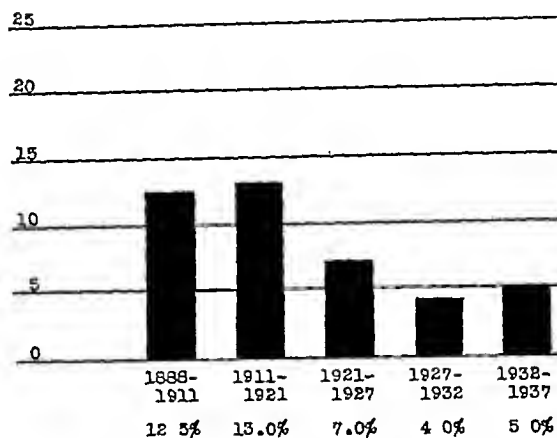


Fig 3 Mortality in multiparous breech delivery of 504 mature single infants, 1888 to 1937

the placenta during the second stage, and the dangers of hurried completion of the extraction should progress be delayed by difficulty with shoulders or head after appearance of the umbilicus at the vulva

We believe that the fetus *in utero* presenting by the breech is essentially a truncated cone, with the smaller end passing first. Certainly this is true of the footling breech, the circumference of which, non-inclusive of the legs, has been stated by von Jaschke as 24 centimeters. The aftercoming head has an average suboccipitofrontal circumference of 34 centimeters according to Williams. Consequently, complete dilatation of the os uteri is seldom if ever encompassed by the dilating action of the breech itself, hence the frequency with which extended arms occur, and the common necessity for applying forceps to the aftercoming head. For this reason we believe that the policy of allowing the breech to crown and the body to be delivered to the umbilicus by the expulsive efforts of the patient herself, aided or not by suprapubic pressure, is no guarantee against these mechanical hazards. On the contrary we believe that a methodical deliberate extraction under full surgical anesthesia after the breech has passed the cervix does not in any way predispose to dystocia of shoulders or head, but actually makes its occurrence less to be feared than under the classical method of management.

The figures of corrected mortality in breech delivery presented in Table III are identical with those in Table I, save that they are arranged for the purposes of this discussion in a somewhat different way. On March 1, 1921, Irving and Goethals undertook as a special assignment on the hospital service to extract all breeches during the second stage. This policy has, in general, been carried on to the present time, although the concept of elimination of the second stage of labor requires some modification. Nelson and Eades, in 1935, found that despite efforts to obviate the second stage in the delivery of cardiac patients 64 per cent of the multiparas investigated by them and 14.1 per cent of the primiparas delivered themselves normally. The second stage of multiparous labor may be very rapid, and even in primiparas the exact moment at which full dilatation occurs is often not determined. A better statement of our policy is to say that extraction is undertaken after, but not necessarily immediately after, attainment of full dilatation with respect to the breech.

The figures indicate that the stillbirth and neonatal death rate has been reduced by more than 50 per cent since the above policy was started. While it is quite likely that other factors, such as increased interest in and watchfulness over the breech labor, may be involved, the fact remains that the figures are all derived from the same institution over

TABLE IV—SUMMARY OF 78 STILLBIRTHS AND NEONATAL DEATHS FROM MECHANICAL CAUSES

	Cases
Group A. Mechanically easy delivery of apparently normal infants, with neonatal death occurring a few hours to several days later with evidences of intra cranial hemorrhage	4
Group B. Mechanically easy delivery with stillbirth, or birth of child in manifestly poor condition who cannot be revived or who dies shortly thereafter	24
Group C. Mechanically difficult or traumatic delivery	40

a period of 50 consecutive years, and that the improvement in results, as shown in Figures 2 (6) and 3 (7) has continued down to the present time. A second special assignment of breech deliveries included in these figures was undertaken by the writer from October 1 1931 to April 1 1933, during which period 83 infants were delivered, with 2 neonatal deaths, accounting for a mortality rate of 2.3 per cent (5). Save for this the breech deliveries have been routinely handled by the resident and house staffs from March 1 1932 to the present.

The stillbirths and neonatal deaths in this series are classified as *mechanical* and *inter current* according to causation. Mechanical deaths are those due to asphyxia or trauma, demonstrable clinically or at postmortem. Inter current deaths result either from incidental pathology of early neonatal life presumably independent of the birth process, or from such purely extraneous circumstances as intra uterine death during labor before admission to the hospital. Nineteen of the 97 fatalities accounted for in this series are so classified.

Study of the 78 mechanical fatalities in this series shows that they occur in one of three ways, as arranged in Table IV.

Group A. Mechanically easy delivery of apparently normal infants, with neonatal death occurring a few hours to several days later with evidences of intracranial hemorrhage. This group may be likened to similar deaths following normal vertex or cesarean delivery.

Group B. Mechanically easy delivery with stillbirth, or birth of a child in manifestly poor condition who cannot be revived or who dies shortly thereafter.

Group C. Mechanically difficult or traumatic delivery.

TABLE V—SUMMARY OF DELIVERY IN 24 GROUP B FATALITIES

	Cases
1. Prolonged second stage of labor with rising or irregular fetal heart	3
2. Sudden loss of fetal heart after admission to hospital, and from 21 minutes to 14 hours before delivery	2
3. Stillbirth occurring in association with normal breech delivery	3
4. Assisted breech delivery with stillbirth or birth of child asphyxiated and dying 30 minutes to 3d day postpartum	5
5. Intrapartum bleeding followed by rising fetal heart	1
6. Easy extraction at full dilatation, baby stillborn or died to 7 hours after birth	1
7. Easy extraction. Baby breathed when head reached perineum, but could not be resuscitated	1
8. Easy extraction after dilatation of early constriction ring	—
9. Easy extraction after prolapse of foot at 4 to 5 fingers' dilatation and sudden loss of fetal heart	24

The two groups of the greatest interest are B and C. Of the 40 fatalities in the last named group 27 or 67.5 per cent, occurred in the era of conservatism, that is, before 1921. On the other hand it is only fair to add that 16 of the 27 were delivered through cervixes which either had not reached full dilatation or which required manual dilatation before extraction was carried out. Since 1921 7 of the 23 group C fatalities occurred following extraction through a cervix which had been incompletely prepared. The effect of this factor upon the mortality rate is tragically apparent.

The 24 fatalities in group B are analyzed in Table V. Study of their records indicate that in 13, or over half something happened during the second stage, quite possibly an occult involvement of the cord. This assumption in view of the frequency of frank prolapse does not seem unreasonable. At all events the evidence suggests that if extraction had been done earlier some, at least, of these 13 dead infants would have survived.

SUMMARY AND CONCLUSIONS

1. The management of breech presentation has been discussed, based upon the corrected statistics obtained from a study of 2035 pelvic breech deliveries and 58 abdominal cesarean sections in the Boston Lying-in Hospital from 1888 to 1937 inclusive.

2 About 7 per cent of primigravidas with breech presentations at term should be delivered by section

3 Roentgenographic mensuration of the fetal head *in utero* has a definite if limited value in helping to diagnose fetopelvic disproportion. The ideal method of making a comparison of the fetopelvic relationship in breech presentation has not yet been determined

4 The statistics and experience derived in this study indicate that, if delivery through the pelvis is selected as the method of choice, the second stage of labor should be terminated by breech extraction under full surgical anesthesia before the birth of the umbilicus, as has been classically recommended, has occurred

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ANOXIA AND OXYGEN THERAPY IN HEAD INJURY

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THE recognition and prompt treatment of conditions due to severe oxygen deficiency is a matter of past history. The vicious circles resulting from mild oxygen want are slowly being recognized. Following concussion of the brain, with or without skull fracture, varying degrees of anoxia might be expected to occur on the basis of shock (stagnant anoxia) alterations of respiration due to injury of the respiratory center (anoxic anoxia) neurogenic hyperthermia due to disturbance of the temperature regulating center (relative anoxia due to increased oxygen demand by the tissues) decreased circulation through the brain due to increased intracranial pressure, vasodilatation edema, and hemorrhage.

The absence of any report in the literature together with the importance of mild anoxia prompted this investigation of anoxia and oxygen therapy upon dogs and patients with head injury. Oxygen had been used at the Henry Ford Hospital in the treatment of patients with cerebral hemorrhage and with head injury upon the suggestion of F. W. Hartman at the time these studies were undertaken.

METHODS

The first part of this investigation was performed upon 9 normal dogs by one of us (J. G. S.). Samples of blood were drawn anaerobically from the femoral artery of the unanesthetized dogs and analyzed for oxygen content, oxygen capacity and oxygen saturation according to the method of Van Slyke and Neill. Under light chloroform anesthesia (1 to 2 minutes) concussion of the brain was then produced by a blow on the head. In order to ascertain the effect of the chloroform dogs 1 to 3 were permitted to recover from the anesthetic and arterial blood samples were obtained 1 hour later. These dogs were then re-anesthetized and brain concussion was pro-

duced. Femoral artery blood samples were again taken 2 to 3 hours later and in 4 dogs, 8 to 24 hours later. Aseptic cisternal puncture was performed upon each dog at the time that the first blood samples following cerebral concussion were drawn and the cerebrospinal fluid pressure and the presence of blood were noted. Oxygen was administered by nasal catheter to 6 of the 9 dogs for from 1 to 2 hours, and blood samples were again taken. Oxygen flow through the catheter was maintained at 8 to 10 liters per minute. According to Barker Parker and Wassell this produces an alveolar concentration of 50 to 55 per cent oxygen.

Blood samples were obtained anaerobically from the femoral arteries of 12 patients with recent head injury at the time of their admission. Routine observations of body temperature, pulse, respiration, and blood pressure were also made. Skull fracture was looked for in the x ray films. Six of the patients were placed in oxygen tents and additional blood samples were obtained 24 to 36 hours later.

RESULTS

The arterial blood oxygen saturation varied from 91.9 to 94.2 per cent in the 9 normal unanesthetized dogs (Table I). Light chloroform anesthesia (1 to 2 minutes) did not affect the arterial blood oxygen saturation. Blood samples taken from dogs 1, 2 and 3 one hour after recovery from the anesthetic showed normal saturation values of 91.2, 92.5 and 91.9 per cent, respectively. Two to 3 hours following the experimental concussion of the brain, oxygen saturation was depressed from 9.3 to 37.4 per cent below normal in 8 of the 9 dogs. All of these dogs were unconscious. Cisternal puncture showed blood to be present in the cerebrospinal fluid in 8 of the 9 dogs and the pressure was elevated from 30 to 58 millimeters of cerebrospinal fluid pressure in 7 of the 9 dogs and was normal in 2. No depression of blood oxygen saturation

From the Department of Neurosurgery, Henry Ford Hospital

TABLE I—ARTERIAL BLOOD OXYGEN IN DOGS FOLLOWING CONCUSSION OF THE BRAIN

Dog	Femoral artery blood oxygen saturation				Cerebrospinal fluid (2-3 hours after injury)	
	Normal per cent	Brain concussion			Pressure	Blood
		2-4 hrs per cent	O ₂ 1-2 hrs * per cent	3-24 hrs per cent		
1	91.0	81	92.9		145	2+
2	92.5	53	84.7		1.5	3+
3	94	60		70.3	112	2+
4	95.2	70.5		84	165	1+
5	92.0	95.4		92.9	95	0
6	92.5	81.4	92.4		156	1+
7	94.2	83.9	92.9	84.7	1.0	2+
8	93.0	52.6	73.0		100	3+
9	92.6	83.3	90.6		122	2+

* Nasal oxygen 5 to 10 liters per minute
Saturation at the end of therapy

was found in dog 5. This dog was unconscious for only about 2 minutes and showed no changes in the cerebrospinal fluid. Its blood oxygen saturation was elevated 2.5 per cent 3 hours later because of hyperpnea. Six of the dogs (Nos. 1, 2, 6, 7, 8, and 9) were given oxygen for 1 or 2 hours at the end of which the oxygen saturation of the blood was determined. The oxygen saturation was elevated in all, it was raised to 90 per cent or above in four, from 57 to 85 per cent in dog 2, and from 52 to 78 per cent in dog 8. These results on dogs with a head injury show that the oxygen saturation of the arterial blood may be decreased by head injury and that it can be elevated by oxygen therapy.

Gas analysis of blood from the femoral arteries of 12 patients with recent concussion of the brain (6 with skull fracture) showed the oxygen saturation to be normal in 2 patients (about 90 per cent), depressed 6 to 10 per cent in 7, 11 per cent in 1, and 34 per cent and 44 per cent in each of the other 2 patients (Table II). Body temperature elevations varied from 0 to 3.4 degrees F while the pulse rate and blood pressure were fairly normal in all except patients 4 and 5, who showed signs of shock with a slightly lowered blood pressure and an increased pulse rate. The first 6 patients were not treated with oxygen. Patients 1, 4, and 5 showed the greatest

TABLE II—ANOXIA IN PATIENTS WITH HEAD INJURY

Patient	Time	Femoral artery blood oxygen saturation per cent	Temperature	Pulse	Respiration	Blood pressure	Skull fracture
1	Admission	91.4 D	101.0	60	25	110/60	+
2	Admission	86.6	99.0	90	0	100/40	0
3	Admission	91.0	98.5	90	36	120/60	0
4	Admission	45.2 D	98.6	136	24	90/40	+
5	Admission	58.4 D	100.2	112	28	100/80	+
6	Admission	89.9	99.0	84	15	104/64	0
7	Admission	81	102.0	62	20	136/50	0
	O ₂ 24 hrs	93.1	100.4	58	0	135/70	
	10 days	94.5	99.6	60	20	—	
8	Admission	84.8	99.4	98	70	120/80	0
	O ₂ 24 hrs	90.8	99.9	86	18	120/70	
9	Admission	86.5	100.8	76	20	134/83	+
	O ₂ 36 hrs *	93.1	100.0	66	20	120/68	
10	Admission	85	99.2	80	20	130/84	+
	O ₂ 24 hrs *	89.6	99.6	80	20	126/76	
11	Admission	86.6	102.4	110	20	90/60	0
	O ₂ 24 hrs *	92.4	99.0	72	18	110/70	
12	Admission	84.6	99.8	86	20	126/80	+
	O ₂ 24 hrs *	91.2	99.0	80	18	120/80	

* Oxygen tent
D Died

depression of oxygen saturation in this group of patients, and died. The remainder of the patients in this series lived. Patients 3 and 6 showed normal blood oxygen saturation values. The high saturation (94 per cent) in patient 3 was associated with a respiratory rate of 36. Patients 7 to 12, all of whom received oxygen therapy, showed a moderate depression of blood oxygen saturation (6 to 10 per cent) upon admission and an early elevation of body temperature. After 24 hours in the oxygen tent, the blood oxygen saturation was restored to and above normal and the body temperature was depressed in all except patient 8 (0.5 degrees F rise).

Although the oxygen therapy reduced the fever and restlessness in some of the patients and although there appeared to be some clinical improvement, opinions regarding the therapeutic efficacy of the oxygen must

be reserved until a large series of patients is observed

EVALUATION OF STUDY

It is not surprising that injury to the brain, which is the site of the respiratory and circulatory centers, results in a depression of blood oxygen saturation below normal. Without prompt treatment, cases of severe anoxia offer a grave prognosis while conditions of mild oxygen deficiency may set up vicious circles. Schnedorf has shown experimentally in dogs that the mild degree of trauma associated with the slow aseptic withdrawal and immediate replacement of 6 to 8 cubic centimeters of cerebrospinal fluid caused marked elevations of intracranial pressure (124 to 156 mm.) an increase in cerebrospinal fluid protein (123 mgm. per cent) cells (1546) and body temperature (39 to 4.2 degrees F) above normal while the arterial blood oxygen saturation was depressed 10 to 15 per cent below the normal level. Similar withdrawal and replacement of cerebrospinal fluid in another series of dogs, in which the blood oxygen saturation was maintained at or above normal by the administration of nasal oxygen, decreased the severity of these reactions. In this group the cerebrospinal fluid pressure rose only 63 to 69 millimeters, proteins were 53 milligrams per cent, and the number of cells in the cerebrospinal fluid was only 673. Elevation of body temperature did not occur. This work shows that moderate anoxemia is responsible in part for the increased permeability of the cerebral vascular system and the subsequent increased intracranial pressure, edema of the brain, and the presence of blood by diapedesis, in the cerebrospinal fluid.

The experiments on dogs show that cerebral concussion causes a depression of arterial blood oxygen saturation below normal and also that the administration of oxygen may increase the oxygen saturation. This increase in the oxygen saturation of the blood occurred within 1 to 2 hours after the institution of oxygen therapy. One to 2 minutes of light chloroform anesthesia employed in this study on the dogs had no delayed effect upon blood oxygen saturation. Dogs 1 to 3 recover

from the anesthesia within 3 minutes and showed normal arterial blood oxygen saturation 1 hour later. In most of the human cases of head injury observed in this study the depression of blood oxygen was mild (5 to 10 per cent) causing only a mild oxygen deficiency however in some cases the depression was as much as 34 to 44 per cent. The elevation of body temperature seen in so many patients with head injury (neurogenic hyperthermia) produces a marked increase in tissue metabolism and an increased demand for oxygen. In these patients the oxygen deficiency therefore may be greater than the level of blood oxygen unsaturation would indicate. Traumatic shock, when associated with head injury results in a lowered blood pressure and produces anoxia of the stagnant type. The question of sedative medication in these patients is an important one. From his statistical study Schreiber feels that anoxemia caused by analgesics and prolonged labor causes damage to the brain and is responsible to a large extent for the apnea, morbidity and mortality of the newborn. Morphine, paraldehyde and the various barbiturates not only cause a depression of blood oxygen saturation but also have a direct depressant effect upon the utilization of oxygen by the brain tissues as demonstrated *in vivo* and *in vitro* by McClure, Hartman, Schnedorf, and Schelling and *in vitro* by Jowett, and by Hundhausen. For this reason, heavy sedation with these drugs should be avoided.

In view of these experimental facts, it is obvious that mild anoxia can be and should be promptly treated. The anoxia can harm the patient whereas oxygen administered properly can only benefit the patient.

CONCLUSIONS

1. The presence of mild as well as severe anoxia should be recognized as an important factor in the morbidity and mortality of head injury with cerebral injury.

2. Brain concussion, with or without skull fracture, caused a depression of arterial blood oxygen from 5 to 44 per cent below normal in dogs and patients.

3. Oxygen therapy restored the blood oxygen saturation to and above normal and

decreased the marked elevations of body temperature to normal. In dogs this occurred in from 1 to 2 hours.

4 The presence of fever makes the oxygen deficiency of the tissues relatively greater than the level of the unsaturation of the arterial blood would indicate.

5 Sedative medication, which causes a further depression of blood oxygen saturation and also a direct depression of the utilization of oxygen by the tissue cells, should be avoided as much as possible.

6 Oxygen therapy is indicated for the

combatting of the anoxia which result from head injury and for the amelioration of reactions which follow brain injury and mild anoxia.

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A CONSIDERATION OF SO CALLED GRANULOSA AND 'THECA' CELL TUMORS OF THE OVARY

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THE Society of Gynecological Pathologists of New York has collected a group of 61 ovarian tumors¹ which have been diagnosed as belonging to the group of neoplasms having their origin in the theca granulosa cell complex. The authors were appointed to study these tumors as well as the clinical data of the patients from whom they originated. The work is as yet incomplete; however the material was found to yield information justifying a partial report at this time.

As the scope of this paper must be limited, no attempt will be made to summarize the literature or to present completely the various points of view concerning etiology, the life cycle or cellular relationships of these tumors. It will not be amiss, however to call the attention of those interested in an exhaustive presentation of the subject, to two monographs which have appeared in recent months: *Les Tumeurs de la Granulosa* by J. Varangot, and *Granulosatumoren* by W. Schiller. We shall consider only those features of the neoplasms which have not been clearly understood and are therefore somewhat controversial.

Despite the very extensive literature that has developed as the result of the study of the tumors since von Kahliden described the first case in 1895 there is still a great deal of confusion concerning their morphological variations, as well as their hormone producing potentialities. The monograph by Varangot illustrates some of the errors that have crept in. In all, 274 so called granulosa cell tumors

have been studied and reported. In 1933 Loeffler and Priesel described what they considered to be a distinct type of tumor of ovarian origin, and named it "fibroma thecocellulare xanthomatodes ovarii." Of this peculiar type of variation of the graafian-follicle-like neoplasms, 22 have been studied and reported. Recently doubt has been expressed as to the validity of the attempt to classify this group of tumors as being separate and distinct from the better known and more frequently seen granulosa cell group for it has been suspected that pure tumors of the two cell types were rare and a number of tumors have been reported in which there existed obvious mixtures of both cells. The title of this paper reflects the caution into which the minds of the authors have been placed as a result of their study of a large group of tumors of the so called granulosa type.

Of the 61 tumors offered for study 7 were excluded because it seemed dubious that they were composed of theca or granulosa cells. As all the tumor material had been fixed previous to this study it was not possible to conduct hormonal studies upon it, and therefore evidence of hormonal activity has been adduced from the clinical history of uterine bleeding or amenorrhea as substantiated by the microscopic appearance of the endometrium. The tissues were studied by a variety of staining methods. In addition to the common tissue stains, Masson's polychrome, and Foot's silver stain were found of most help in differentiating not only the cellular variations but also that which has proved of equal importance the relation of the various cells to the reticular elements of the supporting connective tissue framework. The Hoerr Roman's fat stain was utilized in the studies of differential lipid content.

The general organization of the tumors is interesting and helpful, as a correct inter-

¹From the Women's Clinic of the New York Hospital-Cornell Medical College Association, and the "Society of Gynecological Pathologists of New York."

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The tumor material collected by the Society came from the Bellevue Hospital, Beth Israel Hospital, Margaret Hague Maternity Hospital, Memorial Hospital, New York Hospital, Roosevelt Hospital, Sloane Hospital, Women's Hospital.

pretation of structure gives a clue to the potentialities and life history of the tumor. The survey of the collection of tumors demonstrated that the classification suggested by Robert Meyer is reasonably adequate and useful, as it serves as a means of description of the tumors. This classification provides three main groups: the folliculoid, the cylindroid or trabecular, and the sarcomatoid.

Before going further in a description of the different classes of the tumors, we present a statement of the criteria and the means of differentiating between the two main types of cells, that is, theca and granulosa cells. As has been amply testified by the students of the graafian follicle and the corpus luteum, accurate differentiation between these two types of cells is never easy and is sometimes impossible. However, comparatively little work has been done with the aid of silver impregnation methods, and so far as we are aware, the Foot silver stain has never been used in connection with theca and granulosa neoplasms. This technique has many advantages. It not only reveals the argentifine characteristics of reticulum and cellular cytoplasm, but it also gives a finely graduated tonal differentiation of all the cells. It is distinctly superior to the Da Fano and Cajal methods with which it has been compared in this study. The following description of the differences between theca and granulosa cells is based upon our studies with the Foot silver stain.

Neoplastic granulosa cells occur in islands consisting of from a few to several hundred cells. They seldom exist singly. The islands are surrounded by strands or networks of reticulum carrying with them numerous theca cells and the vascular supply.

The nuclei of theca and granulosa cells are impossible to distinguish from one another, as they contain similar nucleolar and chromatin bodies. However, the cytoplasm of the granulosa cell contains many argentofile granules, whereas the cytoplasm of the theca cell is almost devoid of these bodies. In addition, the theca cell is always in intimate relationship to the reticular framework to such a degree that each cell is surrounded by a capsule of this material which isolates it from its neighboring theca cells. In contrast, the

granulosa cells exist in groups, usually of large numbers, each cell being in immediate contact with its neighboring granulosa cells. The complete island of granulosa cells is surrounded but not penetrated by the reticulum.

The application of these differential points makes it possible to analyze the graafian follicle tumors as to their content of these two types of cells. It is not claimed that the method is completely satisfactory in all tumors, as there were a number of instances in which we were left in serious doubt, however, it is felt that it affords a new approach to the study of this group of tumors, which will yield data not formerly obtainable. The descriptions of the theca cells as given is presented with the knowledge that others, namely, von Werdt, Davanzo, TeLinde, Kauffmann, and Robert Meyer have considered the possible presence of theca cells in tumors of "granulosa nature" but have concluded that they were demonstrable only in small numbers, if at all.

The folliculoid type of tumor is one that most definitely tends to produce the tissue to which it is related, and structurally, more or less completely simulates the graafian follicle. These represent the most differentiated type of the tumor and always contain not only granulosa cells lining the follicles, but also numerous theca cells filling the interstices of the supporting connective tissue of the lamina propria. In other words, these are true follicular tumors and are mixed in the sense that they contain both theca and granulosa cells. Approximately 20 per cent of our tumors fall into this category. They all produced large quantities of hormone, as judged by the history of uterine bleeding and the finding of hyperplastic endometrial tissue. None of our folliculoid group had malignant characteristics either clinically or histologically.

A much larger group than the foregoing is composed of tumors in which the potentialities for differentiation are less marked. That is, they are composed of large groups of cells growing in sheets, or round or oval islands. This type of tumor has been called "cylindroid" by Robert Meyer, which term does as well as any other, but lacks the inclusive descriptive characteristics which one who

studies the tumors soon learns to desire. The configuration of the islands of cells is determined first by the fundamental fact that they do not possess the ability to differentiate into follicles, and second by the relationship which the connective tissue bears to the immature tumor and then tends to modify as the tumor becomes older. The granulosa cells are accompanied, as in the folliculoid type of tumor by a supporting reticulum in which one finds many theca cells. As the theca cells have a shorter life cycle in the sense that they become luteinized and undergo collagenous degeneration earlier than the granulosa cells, the sheets of granulosa become divided in various patterns to form the columns of cells suggested by the term *cylindroma* but just as often, the division involves a much finer pattern with the formation of connecting lattices of fibrous tissue so that the strands of granulosa cells give a watermarked silk or trabecular effect.

If one examines a young tumor of this variety which has been stained to demonstrate not only the theca and granulosa cells, but also the reticulum, one will find that it has no well defined cellular arrangement, but is composed of a conglomerate mixture of both granulosa and theca cells the former tending to be arranged in very small groups which are surrounded by extensive irregular areas in which reticulum supporting and containing theca cells predominates. Several such tumors have been reported and correctly interpreted, the most recent one having been described by Greenhill. As the young tumor matures, the theca cells undergo collagenous degeneration and this material, together with the reticulum, serves to divide the granulosa into various patterns depending upon its extent and deployment, on the one hand, and the multiplication of the granulosa cells, on the other. The *cylindroid* or trabecular type of tumor represents about 44 per cent of the material of this study. They always produced estrone in our series, and hence, hyperplasia of the endometrium during the phase of maturity of the granulosa cells however when these cells are few in number or immature, as well as after they have undergone a considerable degree of luteinization and subsequent de-

generation, they may produce such small amounts of hormone as to actuate no hormonal phenomena which can be determined clinically. Luteinization in small degree is exceedingly common in this type of neoplasm. Major degrees of luteinization are rare however one of our tumors measuring 12 by 15 by 26 centimeters had almost completely undergone this lipoid change. Two of the eight instances of malignancy occurred in the *cylindroid* type of tumor.

The third general type of tumor has been called the undifferentiated or "sarcomatoid" group. About 26 per cent of our tumors fall into this classification. It is in the sarcomatoid group that pathologists quite naturally make the greatest number of diagnostic errors, inasmuch as the clinical and histological characteristics are prone to wide variation. In this group the cells maintain growth in uninterrupted sheets until maturity or until various types of degeneration disrupt them. The theca cells and the reticulum are usually found, but to a lesser degree than in the foregoing types. As would be expected, the incidence of malignancy is highest in this group and the life cycle of the tumor seems to be a shorter one than in the other subdivisions. Degeneration due to hematoma formation, ischemia, and senescence, is more common. Very often these tumors do not produce enough hormone to make their presence evident clinically. When they survive for any considerable time, they undergo extensive fibrosis so that one finds huge areas of hyalinized and fibrous connective tissue surrounding comparatively small islands of granulosa cells. In the extensively fibrosed state, one may find no surviving theca cells.

To the foregoing classification we would like to present two other categories, namely the *pure granulosa cell tumor* and the *pure theca cell tumor*. This is done with many reservations, as it seems rather unlikely that there can be many tumors which, if subjected to sufficient scrutiny will qualify as members of either of these two groups. However with the material available the authors have been forced to classify 4 of the 54 tumors as pure theca cell tumors, and 2 as a pure granulosa cell tumor. It would seem almost certain,



Fig 1 Margin of normal graafian follicle showing relationship of reticulum to theca and granulosa cells. The reticulum forms a network about each theca cell and also a definite line of demarcation between theca and granulosa layers.

from what is known of graafian follicle tumors, that if each tumor could be examined at various stages in its growth instead of just at one, there would be times when both of the cortical layers of the follicle would be represented in the neoplasm. The pure granulosa cell tumor of our collection is poor in connective tissue, the columns of granulosa cells being supported largely by the blood vessels and a meager connective tissue. At the center of each group of cells, there is apt to be found a Call-Exner body, although this is by no means constant. There is a small number of cells which have undergone luteinization, indicating that it is not an immature tumor. Mitotic figures are not seen. It is a variation of the graafian follicle tumors, which from all available criteria is well stabilized. It produced a marked hyperplasia of the endometrium which was associated with profuse uterine bleeding.

The four pure theca cell tumors are almost identical with one another in structure. They are composed of a very extensive and dense framework of reticular fibers. Each theca cell is enveloped in a capsule of reticulum. Many of them are luteinized and there are large areas of collagenous degeneration. No islands of granulosa cells can be found. There are no mitotic figures, indeed, the whole picture is one of markedly quiescent growth, suggesting a very cellular fibroma of the ovary. Many readers will doubtless at once credit these four



Fig 2 Follicular type of graafian follicle tumor (Foot's silver stain) a, Low power shows granulosa lining the acini and tongues of reticular connective tissue in the lamina propria. b, High power of same tumor shows the marked differentiation of granulosa and theca elements, the latter being embedded in a reticular network similar to that seen in the normal follicle.

"pure theca cell" tumors to the category of ovarian fibromas. The authors have carefully considered the validity of this conclusion and have decided that the tumors certainly are not ordinary ovarian fibromas, but have every appearance of being theca cell tumors. Moreover, they give the characteristic sudan staining reaction with the Hoerr-Romeis method. Doubtless, some ovarian fibromas are associated not only with theca cell tumors, but in our opinion, may be the results of degeneration of small tumors containing many granulosa cells.

Most interestingly, none of these tumors produced any appreciable hormone. If these be truly theca cell tumors, and we feel that they are, then this finding is most suggestive

studies the tumors soon learns to desire. The configuration of the islands of cells is determined first by the fundamental fact that they do not possess the ability to differentiate into follicles, and second by the relationship which the connective tissue bears to the immature tumor and then tends to modify as the tumor becomes older. The granulosa cells are accompanied, as in the folliculoid type of tumor by a supporting reticulum in which one finds many theca cells. As the theca cells have a shorter life cycle in the sense that they become luteinized and undergo collagenous degeneration earlier than the granulosa cells, the sheets of granulosa become divided in various patterns to form the columns of cells suggested by the term "cylindroma" but just as often, the division involves a much finer pattern with the formation of connecting lattices of fibrous tissue so that the strands of granulosa cells give a watermarked silk or trabecular effect.

If one examines a young tumor of this variety which has been stained to demonstrate not only the theca and granulosa cells, but also the reticulum, one will find that it has no well defined cellular arrangement, but is composed of a conglomerate mixture of both granulosa and theca cells, the former tending to be arranged in very small groups which are surrounded by extensive irregular areas in which reticulum supporting and containing theca cells predominates. Several such tumors have been reported and correctly interpreted, the most recent one having been described by Greenhill. As the young tumor matures, the theca cells undergo collagenous degeneration and this material, together with the reticulum, serves to divide the granulosa into various patterns depending upon its extent and deployment, on the one hand and the multiplication of the granulosa cells, on the other. The cylindroid or trabecular type of tumor represents about 44 per cent of the material of this study. They always produced estrone in our series, and hence, hyperplasia of the endometrium during the phase of maturity of the granulosa cells; however when these cells are few in number or immature as well as after they have undergone a considerable degree of luteinization and subsequent de-

generation, they may produce such small amounts of hormone as to actuate no hormonal phenomena which can be determined clinically. Luteinization in small degree is exceedingly common in this type of neoplasm. Major degrees of luteinization are rare; however one of our tumors measuring 12 by 15 by 16 centimeters had almost completely undergone this lipid change. Two of the eight instances of malignancy occurred in the cylindroid type of tumor.

The third general type of tumor has been called the undifferentiated or "sarcomatoid" group. About 26 per cent of our tumors fall into this classification. It is in the sarcomatoid group that pathologists quite naturally make the greatest number of diagnostic errors, inasmuch as the clinical and histological characteristics are prone to wide variation. In this group the cells maintain growth in uninterrupted sheets until maturity or until various types of degeneration disrupt them. The theca cells and the reticulum are usually found, but to a lesser degree than in the foregoing types. As would be expected, the incidence of malignancy is highest in this group and the life cycle of the tumor seems to be a shorter one than in the other subdivisions. Degeneration due to hematoma formation, ischemia, and necrosis is more common. Very often these tumors do not produce enough hormone to make their presence evident clinically. When they survive for any considerable time, they undergo extensive fibrosis so that one finds huge areas of hyalinized and fibrous connective tissue surrounding comparatively small islands of granulosa cells. In the extensively fibrosed state, one may find no surviving theca cells.

To the foregoing classification we would like to present two other categories, namely the *pure granulosa cell tumor* and the *pure theca cell tumor*. This is done with many reservations, as it seems rather unlikely that there can be many tumors which, if subjected to sufficient scrutiny will qualify as members of either of these two groups. However with the material available, the authors have been forced to classify 4 of the 54 tumors as pure theca cell tumors, and 1 as a pure granulosa cell tumor. It would seem almost certain

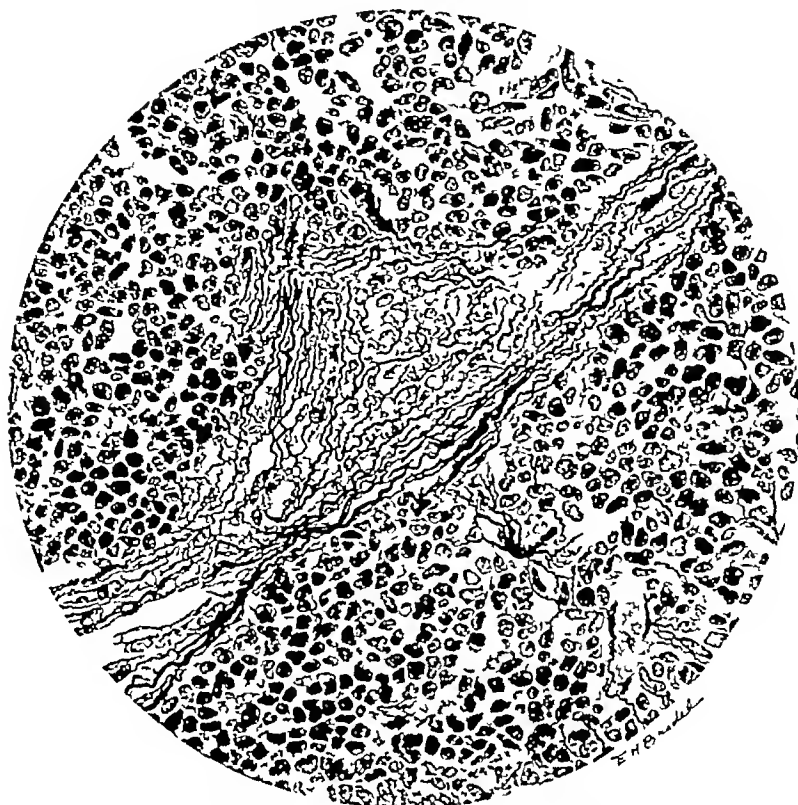


Fig 5 The junction between three lobules of a cyllindroid type of graafian follicle tumor is shown in the drawing. The septum of reticulum fibers contains many well preserved theca cells. In other areas of the same tumor the granulosal growth of the lobules had compressed the intervening septa so that only a few theca elements survived. The relationship as shown may be observed in the great majority of so called "granulosa cell" tumors.

activity, either clinically in the form of excessive uterine bleeding, or histologically by the production of a hyperplastic endometrium. Our attention was called to them by the frequent notation in the history that the patients were suffering from amenorrhea. That 28 per cent of such a group should fail to present the generally accepted evidences of hormonal activity, demands an explanation. We have found that the tumors associated with amenorrhea have in common one or more of the 3 following characteristics: (1) they are relatively undifferentiated, belonging usually to the sarcomatoid group, or (2) they have a high theca cell content, or (3) they are markedly fibrosed or have undergone other forms of degeneration. The 4 pure theca cell tumors, of course, fall into this category, as

all were associated with the lack of any form of excessive uterine bleeding or hyperplasia of the endometrium. In the undifferentiated cell group, 2 different conditions were found characteristic of the granulosa cells, which may be of importance, namely, they were either of the immature cell type and may have been abnormal for that reason, or they appeared to be postmature as evidenced by considerable areas of luteinization. Thirty-six tumors of the collection gave ample and unmistakable evidence of pronounced estrogenic activity. No information was available concerning the 3 others.

Two tumors of the series were associated not only with amenorrhea but with evidences of masculinization. The clinical picture of the 2 patients is almost identical. They exhibited

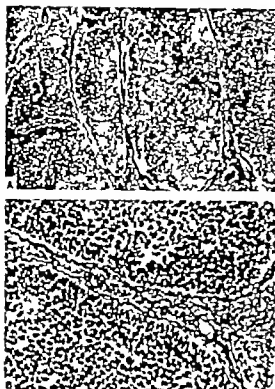


Fig. 3. Cytoendometrial type of graafian follicle tumor (Foot's silver stain). a, Low power shows general topography of the tumor. The large islands of granulosa have very moderate reticular framework surrounding them. Here and there, a few theca cells can be discerned in the reticular net. This tumor is predominately granulosa, with only moderate representation of the theca cells. b, High power shows reticular border between the granulosa islands and theca elements are strikingly demonstrated.

of the possibility that the theca cell does not produce an estrogenic hormone or at least does not secrete estrone as has been generally supposed. From these observations it would seem probable that most of the theca cell tumors reported in the literature as having been associated with evidence of estrone activity might be explained by the possibility that they were not pure tumors of theca cells but contained fairly large numbers of granulosa cells as well.

It is not suggested that the theca cell never secretes estrone as that conclusion is not justified from the observation of only 4 pure theca cell tumors. Conclusive evidence can come only as the result of the study of many



Fig. 4. Sarcomatoid type of graafian follicle tumor (Foot's silver stain). a, Low power shows a very loose diffuse type of reticular framework common in immature or undifferentiated tumors. With this magnification, it is impossible to differentiate the two types of cells which make up the tumor. Actually theca cells constitute about one-half the cell mass, while granulosa forms the other half. b, High power center shows an area of the tumor in which granulosa predominates, but on the right of the picture theca elements are recognizable. High power at bottom, from another portion of the same tumor shows almost pure theca cell growth with only a few granulosa cells discernible.

tumors in various stages of development. As stated our 4 tumors all gave evidence of maturity and of some senescence it is therefore entirely possible that younger tumors may be capable of hormone production. However additional evidence will be given later to show that the higher the content of theca cells is found to be in a given graafian follicle tumor the less likely its association with evidence of hormone production.

ENDOCRINE ACTIVITY

Of the 54 graafian follicle tumors, 15 were found to afford no evidence of hormonal

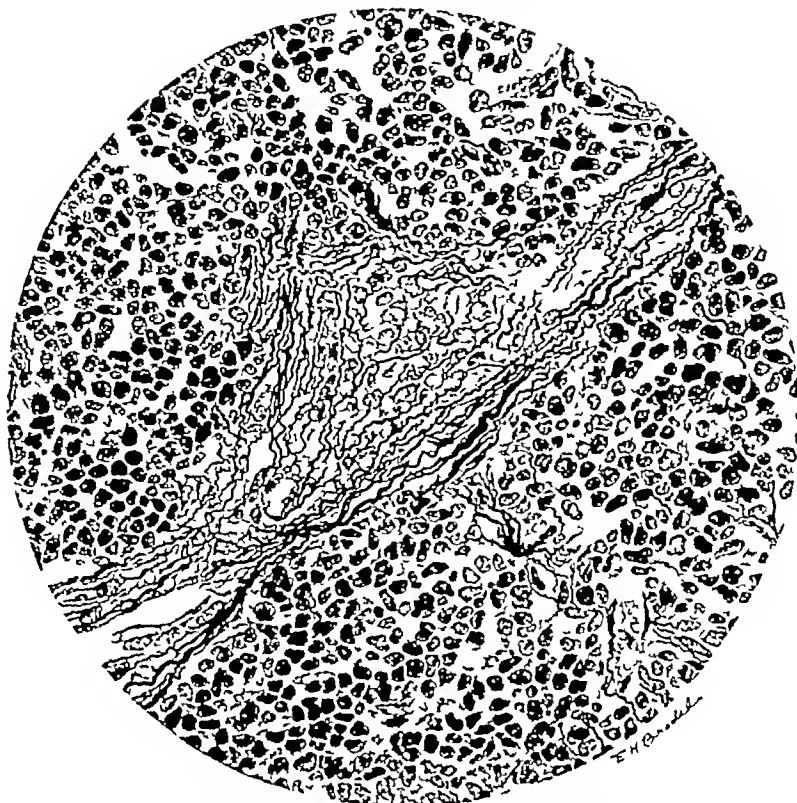


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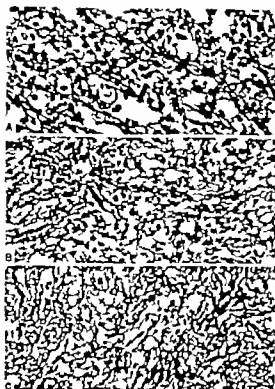


Fig. 6. Three granulosa follicle tumors, showing the mixture of the 2 types of cells. a, Predominately theca in nature but many granulosa cells are demonstrable. b, Also composed mainly of theca cells, with only slight granulosa represented. c, Another example of the mixture of cells.

marked bodily hair growth with masculine distribution, deepening of vocal pitch, breast atrophy, hypertrophy of the clitoris and amenorrhoea. One of these tumors has a typical folliculoid arrangement and seems to be an undoubted granulosa cell tumor while the other is of cylindroid type and while it contains no areas that suggest the possibility of its being an undifferentiated arrhenoma, that possibility cannot be entirely ruled out. After the removal of the first tumor the patient resumed normal menstruation although she has not conceived to date. Unfortunately the second patient died as a sequel to the operation, so that nothing can be known concerning her potentialities for resumption of normal endocrine functions. We are not in a position to elucidate these paradoxical exceptions to the usual feminine

endocrine pattern which is associated with the graafian follicle tumors. Several other instances have been reported in the literature. Most of these instances have been associated with what have been described as luteinized tumors, which suggests the possibility that they may actually have been tumors arising from adrenal rests either in the vicinity of the ovary or actually incorporated in the organ. Examination of the tissues of the 2 cases which are here reported seems to preclude this possible explanation as applicable to these 2 instances.

AGE INCIDENCE

The usual teaching concerning the incidence of granulosa follicle tumors has been that the granulosa type was most frequently seen in the postmenopausal period, whereas the theca cell type was more frequently observed during the reproductive period. This series of 54 tumors is distributed in a somewhat different age relationship. During the first decade of life 1 tumor occurred during the second 2 tumors the third 3 the fourth, 12 the fifth, 19 the sixth, 9 and the seventh, 7. In other words, 69.81 per cent or nearly 70 per cent, may be said to have occurred prior to or during the menopause (the average menopausal age in New York being 49+) and 30.19 per cent after its advent. The greatest incidence of the tumors was from the age of 30 to 50 years. Inasmuch as this roughly corresponds to the reproductive period it was thought that it might be instructive to learn whether or not there was any relationship between parity and the incidence of the tumors. In the fourth decade it was found that 8 of the 12 women were either nulliparae or primiparae. In the fifth decade nulliparae and primiparae equally balanced the multiparae. This is too small a series to evaluate such data, but it is suggested that parity may perhaps tend to reduce the incidence of the tumors.

AMENORRHOEA, OR LACK OF UTERINE BLEEDING

Failure of the tumor to produce sufficient hormonal stimulation to cause hyperplasia of the endometrium followed by uterine bleeding

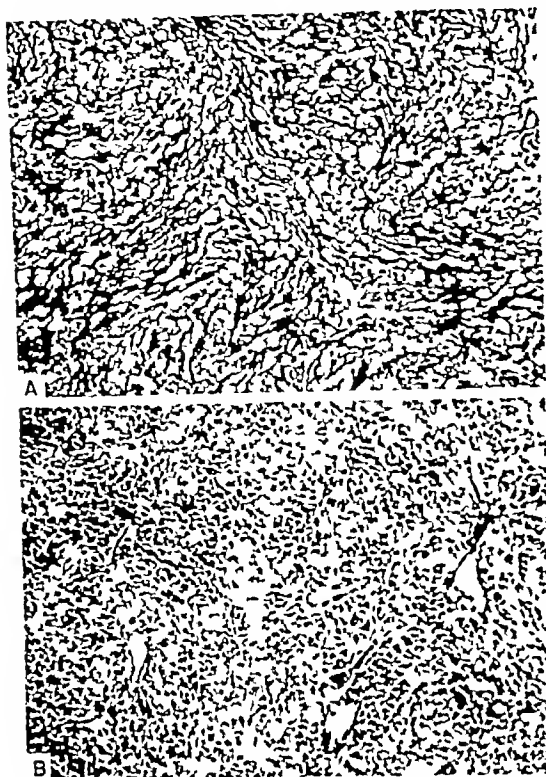


Fig 7 a, Pure theca cell tumor with low magnification, showing the highly developed reticulum and cell content b, Pure granulosa cell tumor is shown in contrast Note the paucity of reticulum and complete lack of theca cells

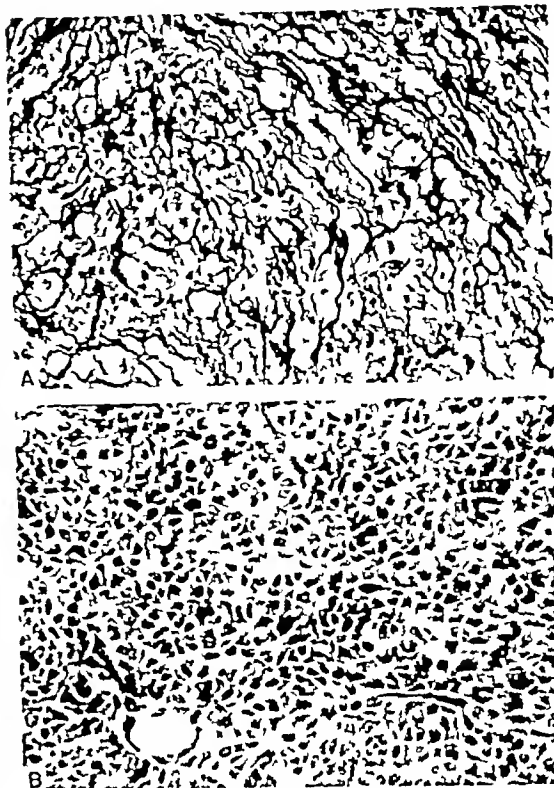


Fig 8 High power photomicrographs of the two tumors which are represented in Figure 7 a, Theca cell tumor, b, granulosa cell tumor

was characteristic of 15 of the patients of the series, an incidence of 28.3 per cent

Uterine bleeding as a result of pronounced estrogenic activity, with or without hyperplasia of the endometrium, was present in all the remainder, with the exception of 3 patients concerning whom no data were available. Of those who failed to produce the symptom of uterine bleeding, all but 2 individuals were preclimacteric. These 2 patients were 50 and 55 years of age.

The tumors were unilateral in 44 of the patients, occurring with equal frequency upon the right and left. Six patients had bilateral tumors and no data were obtainable concerning 4 of the cases. Ascites was found on 7 occasions. In 2 of these the fluid was blood-tinged. Only 2 of the tumors associated with ascites proved to be malignant, and in each instance the fluid was a clear straw color. On

one occasion, hydrothorax was a prominent feature of the patient's physical examination, and abdominal fluid was found at the time of operation. However, the tumor in the ovary proved to be quite benign.

SIZE

The largest tumor of the series measured 18 by 20 by 22 centimeters and occurred in a woman of 37 years. Two very small tumors were found, 1 measuring 5 by 7 millimeters, and the other 15 millimeters in diameter. No correlation could be found to exist between the age of the patient and the size of the tumor.

MALIGNANCY

Eight, or 15.4 per cent of the tumors, were clinically and histologically malignant. Of these patients, 5 died of the disease within a

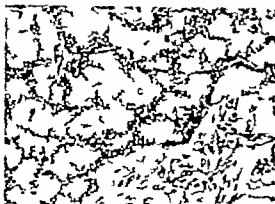


Fig. 9. Granulosa cell tumor. A, very unusual granulosa cell tumor showing various stages in the life cycle of neoplastic granulosa cell. B, Granulosa cell in various stages of mat. rity; C, lutein cells. C, area of collagenous degeneration. D, fibrous.

comparatively short time after its recognition while another died of postoperative pneumonia. Of 2 of the patients nothing is known. Only 1 patient has survived for 4 years and is apparently quite well. She received postoperative deep x-ray therapy because of peritoneal and cul-de-sac metastases. Five other patients received deep x-ray therapy, 3 of them after operation while 2 received both pre-operative and postoperative treatment of this type all died within 14 months. It would seem therefore that in the malignant group of tumors, x-ray therapy is not effective in retarding or stopping the progress of the growth. The very short time interval passing between the treatment and the demise of the patient would seem to warrant this conclusion.

EFFECT OF INTRA UTERINE RADIUM IRRADIATION

Inasmuch as radium is frequently used in the cavity of the uterus for the treatment of a variety of gynecological diseases and particularly because it is known that radiation of the immature mouse ovary can produce graafian follicle tumors it is interesting to note what if any stimulating effect there may be in the ovary of the woman. In the material under study there are just 2 instances that may throw some light upon this question. One patient received 1,200 milligram hours of radium irradiation which was followed 20

months later by the removal of a benign granulosa cell type of tumor. The other patient received a much larger dosage, 3,600 milligram hours which was also followed some months later the exact time is not known by the appearance of an ovarian tumor of the granulosa type which required removal. This tumor was also benign.

These data are insufficient to warrant conclusions. They do indicate however that radiation of this type does not prevent the appearance of the tumor and does not destroy it if it is already present.

THE LIFE CYCLE OF GRAAFIAN FOLLICLE LIKE TUMORS

The ultimate etiology of the human tumor is still in doubt, although Furth and Butler, worth Trout and Butterworth, and more recently Geist all working with the experimentally produced granulosa tumor of the mouse's ovary have shown that in this animal the tumor does not arise from the celomic epithelium as has been taught formerly but forms from elements of the connective tissue of the ovary. This evidence reinforces the thesis of Flischel and his school who have maintained that the cellular elements of the graafian follicle are developed by differentiation of the mesodermic elements of the ovary. Meyer's hypothesis that differentiated mesoderm is produced in excess of that necessary to envelop the primordial ova and that, hence cell nests of this cellular material remain in the ovary occasionally for long periods of time with subsequent development into a neoplasm is still valid. The cell nests have been demonstrated and tumors of all dimensions are described in the literature. It is safe to say that no one today believes that the graafian follicle tumors originate from the differentiated follicle, the corpus luteum or even the atretic follicle.

The stimulus which may cause the residual islands of embryonic cells to develop is not known however the greatest incidence of the tumors coincides with the period of greatest gonadotropic activity of the anterior lobe of the hypophysis that is, during the reproductive period and the early years of the menopause. It may not require too great a

stretch of imagination to suppose that the stimulus which causes the normal cells of the graafian system to proliferate has a similar effect upon the residual embryonic cell nests causing them to assume neoplastic tendencies.

Whatever the growth stimulus may be, it is quite clear that it is not always present in uniform degree. The evidence for this conclusion lies in tumors which frequently show wide variation in the age of various portions of the same tumor. The result of periodic growth is that the neoplasm is frequently an aggregate of groups of cell masses produced at different times and having different degrees of maturity and senescence. The immature cells probably do not secrete hormone, and as the same is true of the senescent cells it is evident that the composite effect of the tumor in the hormonal sense at any given time, must represent the resultant activity of the groups of cell masses which have recently reached maturity. Therefore, the tumor cannot maintain an even level of hormone production but must present wide fluctuations dependent upon the state of growth and nutrition, with the result that response in other organs must also fluctuate in an irregularly periodic manner. In addition various collateral events may occur which tend to minimize the hormonal effectiveness of the tumor, such as ischemic necrosis and hematoma formation. The latter is very common in the folliculoid type of tumor. These facts explain quite satisfactorily why some women are amenorrheic at the time they come to the physician.

Most graafian follicle tumors produce symptoms which bring the patient to the physician, with the result that the great majority of tumors are removed before they have reached the end of their life cycle. It is, therefore, necessary to postulate what some of the terminal aspects of the neoplasms may be. However, we know that if the tumor is not adversely affected by such accidents as ischemia and hematoma formation, the cells tend to mature and to undergo quite typical degenerative changes. The theca cells reach the end of their life cycle sooner than do the granulosa cells. Luteinization occurs in both types of cells and this is followed by collagenous degeneration, which is replaced by

fibrosis. The greater the content of theca cells, the more likely the tumor is to produce fibrous connective tissue. The granulosa elements, however, being poorly supplied with supporting framework upon which to dispose themselves, and being less intimately supplied with blood vessels are more prone to premature accidents which interrupt the other forms of degeneration that might otherwise ensue.

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1. A study of 51 ovarian tumors of the theca granulosa cell group is reported.

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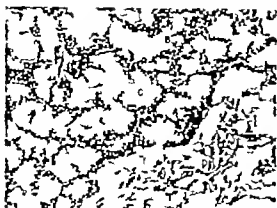


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THE ANATOMY OF THE SUBPERITONEAL TISSUES AND LIGAMENTOUS STRUCTURES IN RELATION TO SURGERY OF THE FEMALE PELVIC VISCERA

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IN a previous article (Curtis, Anson, McVay, 1939) the anatomy of the pelvic and urogenital diaphragms was described anew, especially in relation to factors important in pelvic repair. Therein, attention was directed to the firm fascia which lines the muscular floor of the pelvis and is termed the superior fascia of the pelvic diaphragm; it was demonstrated that where the pelvic viscera pierce the pelvic floor the fascia is carried upward upon these hollow organs as tightly fitting investments or "collars," sometimes blending with, even becoming almost inseparable from, the outer muscular coat of each.

The present offering presents a continuation of our investigation, based on further observations in the operating room correlated with dissections of human material, substantiated by necropsy dissection of fresh specimens. A chief objective of this article is to discuss the relation of the endopelvic fascial collars to the ligamentous and cellular investing and supporting tissues at a higher level, chiefly in their relationship to the uterine supports and adjacent associated structures. The illustrations are from life-size drawings by Tom Jones made from successive dissections of a single carefully selected specimen.¹

Although it is intended to integrate the anatomical details hereinafter described with those of the more inferior pelvic region previously considered, the regional anatomy may

be most logically discussed in conjunction with the illustrations by considering the structures in the order in which they are encountered in pelvic dissection from within the abdomen, from above downward.

The commonly encountered descriptions of the pelvic organs are, in their general features, in accord with the observations made in the present investigation. Nonetheless, since knowledge of the form and relations of these viscera is fundamental to an understanding of the regional variations in the character of their serous and fibrous investments and their ligamentous supports, certain of these well recognized anatomical facts will be mentioned in the course of our description.

I PERITONEUM

In the specimens studied, including the one presently to be described, the course of the peritoneum conforms to the descriptions presented in standard textbooks of gross anatomy.

From the internal surface of the anterior abdominal wall the peritoneum is conducted downward to the superior surface of the urinary bladder, only this superior surface is covered by peritoneum, the inferolateral and posterior surfaces being separated from the back of the pubic bone and the fascial covering of the obturator internus and levator ani muscles merely by a thin stratum of extraperitoneal connective tissue. From the superior surface of the bladder the peritoneum is next reflected to the anterior surface of the uterus, slightly above the level of the internal os of the cervix, from each lateral border of the uterus it is then carried, wing-like, to the side wall of the pelvis, as the anterior leaf of the broad ligament. Continuing over the fundus of the uterus, the peritoneum descends upon the posterior surface of the uterine body and the posterior wall of the vagina to the level of the external os of the cervix, draped over the uterine tube at either border of the uterus, it passes downward as the posterior leaf of the broad ligament. Extending to the front of the rectum, the peritoneum is reflected upward to the pelvic colon.

From the Department of Obstetrics and Gynecology and the Department of Anatomy (latter's contribution No. 292) Northwestern University Medical School. The clinical aspects of this investigation were discussed by Dr. Arthur H. Curtis in a paper read before the American Congress of Gynecology and Obstetrics, Cleveland, September 12, 1939. This paper is entitled "Special features in the management of surgically difficult malignant growths and kindred lesions of the pelvic viscera."

¹The subject was a white female, 30 years of age, 5 feet 7 inches tall, weighing 86 pounds (embalmed). The abdomen and pelvis were completely free of pathology. The illustrations are two-thirds actual size.

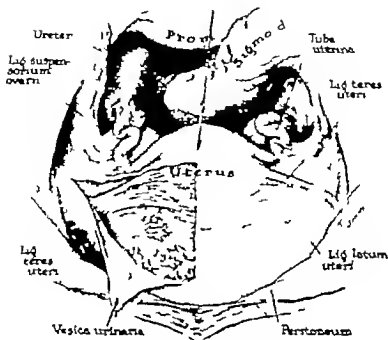


Fig. Subperitoneal tissue of broad ligament, of urinary bladder and uterus. Anterior view. The uterus has been retracted from its normal anteroverted position, the peritoneum removed from the body of the uterus, the broad ligament, and the superior surface of the bladder.

In covering the pelvic organs the degree of fixation of the peritoneum to the intrinsic tissues of these viscera differs with the organ concerned, seemingly dependent upon the thickness and character of the subperitoneal connective tissue. These regional differences in peritoneal anchorage are important enough, in anatomy and gynecology, to warrant special description.

On the uterine corpus the peritoneum is closely adherent to the musculature, there being no demonstrable fascial investment at this superior level (see hereinafter) upon removal of the peritoneum from the posterior surface of the uterus the musculature is at once exposed as far downward as the attachment of the uterosacral ligaments (Fig. 3) the

anterior peritoneal leaf is similarly firmly adherent above but much more loosely attached near the bladder. Over the urinary bladder only a slight amount of areolar tissue separates the peritoneum from the vesical collar of the endopelvic fascia (Fig. 1). Of the three pelvic organs, the rectum is least firmly fixed to its peritoneal covering, a clean separation being easily effected between the latter and the rectal collar of the endopelvic fascia (Figs. 3, 7).

II. ENTRAPERITONEAL "CELLULAR TISSUE" (TELA SUBSEROSE)

The histological fabric of the several supporting structures is fundamentally similar, yet it is important in surgery and in gross

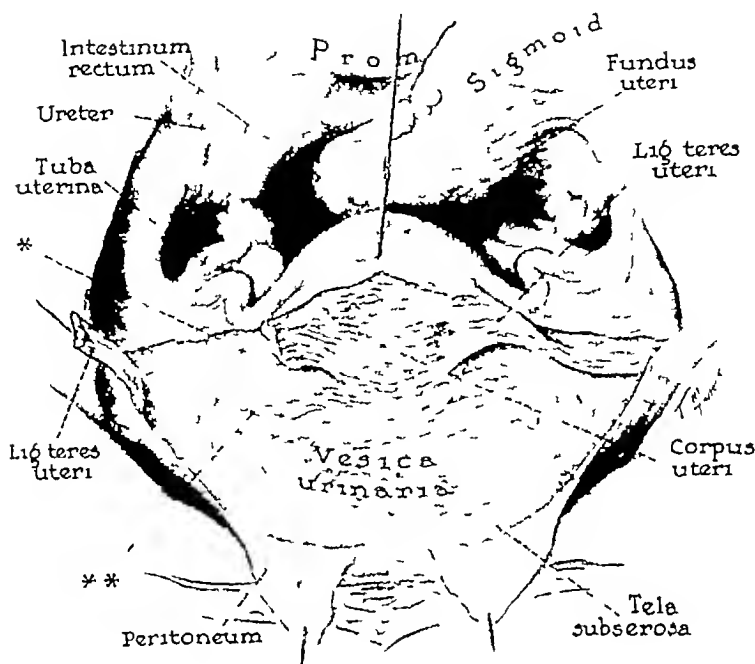


Fig 2 Structures within the broad ligament. Anterior view. The peritoneum in the ante uterine part of the pelvis has now been almost completely reflected. The round ligaments exposed, the round ligament of the specimen's right side transected near its uterine extremity. The band like nature of these ligaments is thus demonstrated, their relation to the musculature of the uterus and to the uterine fascial collar (endopelvic fascia) is likewise shown. *Indicates the area of thin parametrium, **the site of the uterine vein (see Fig 4)

anatomy to distinguish between the several categories—an areolar or loose packing, a strong sheet-like derivative of muscle fascia, a heavy band-like ligament, a sheath locally thickened to house blood vessels. While consisting chiefly of connective tissue, a considerable amount of muscular tissue may be associated with the fascia and the ligaments.

First to be considered is the subserous connective tissue (tela subserosa)

The subserous layer of connective tissue lies between the peritoneum and the fascia covering the internal aspect of the parietal and the abdominal musculature. It provides support for the mesothelial cells of the peritoneum and serves as a packing between the different organs and around the vessels, nerves and ducts.

In the abdomen, the extraperitoneal tissue like the peritoneum is conveniently divisible into two portions the parietal and the visceral. The former

lines the abdominal cavity, while the latter, continuous with that part which lies upon the posterior abdominal wall, is carried forward between the layers of the mesenteries to the several portions of the digestive tube. Whether retroperitoneal or mesenterial, the abdominal part of the subserous stratum is simple in character, being chiefly of the fatty areolar variety.

But in the pelvis the disposition of the subserous tissue in relation to the organs is of a complex nature. Since the peritoneum invests only certain surfaces of the digestive, generative, and urinary organs, a considerable surface area is related to the subserous tissue, either directly or indirectly, it is directly related whenever the tubular prolongation of the pelvic fascia is wanting indirectly wherever this fascial "collar" definitely intervenes between the muscular coat of the organ and the subperitoneal layer. Current descriptions of these relations leave much to be desired. Thus, in Cunningham's textbook the extraperitoneal tissue is regarded merely as part of an extensive fascial system which lines the whole of the body cavity, outside of the various

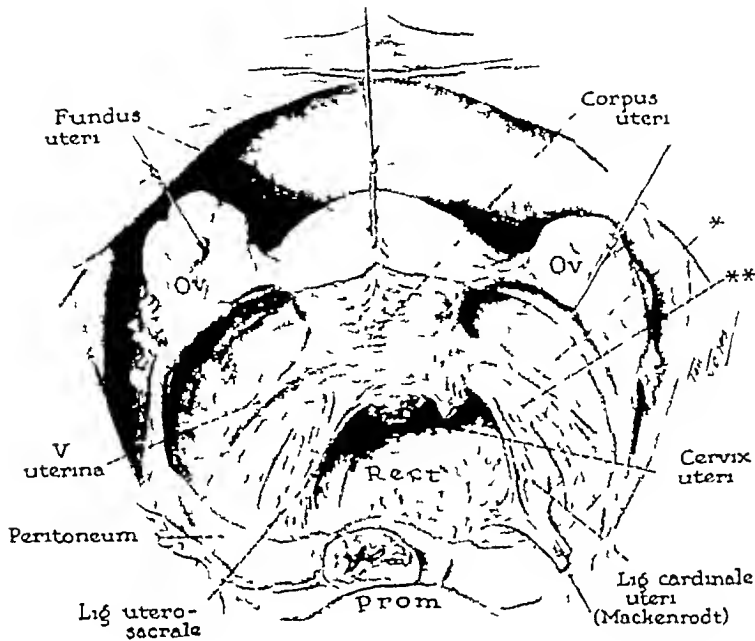


Fig 4 Supporting structures of the uterus Posterior view The entire posterior leaf of peritoneum has been removed from the broad ligament On the right side the uterosacral ligament has been cut to show the depth of the recess for which it forms the roof (see left side, intact) *Indicates the area of thin parametrium, **the thicker part which forms a sheath for the vessels

Vesical part On each inferolateral surface of the urinary bladder the subserous tissue is of a loose consistency, so easily dissectable that the organ may be mobilized by blunt dissection. On the superior surface it is also thin but somewhat stronger, here it is so intimately fastened to the fascial investment derived from the pelvic diaphragm that separation of the overlying peritoneum is rather difficult. At the base of the bladder, although surgically dissectable by blunt dissection, this tissue is likewise resistant, rendering the connection between the fascial coverings of bladder and uterus (and vagina) a strong one, here, too, it contributes to the substance of the vaginovesical ligaments ("pillars of the bladder"). These pillars fasten the uterus firmly to the bladder, but between them the two viscera are separable—an important consideration in the repair of

urethrocele and cystocele. The uterus and bladder are not, then, so intimately held together that their adjacent fascial collars, with the intervening cellular (or areolar) tissue, can be considered as constituting an indiscriminate "vesico-uterine septum."

Uterine part Over the fundus of the uterus, and upon the anterior and posterior surfaces of the body of the organ, the subserous layer scarcely exists as a grossly discernible stratum, but on either border of the body of the uterus it is continuous with the portion of the parametrium situated between the uterine tube above and the uterine vein below, this tissue is finely areolar in character, similar to that intervening between the layers of the mesentery in a spare subject, it is so sparse that, when one peritoneal layer of broad ligament is removed, the thin areolar stratum, with remaining peritoneal leaf, falls away loosely

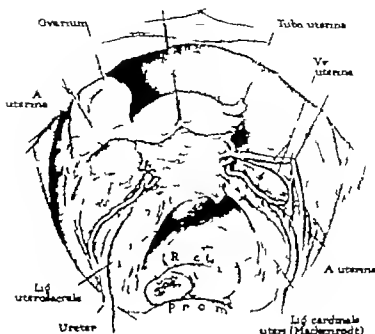


Fig 3 Structures within broad ligament, sacral (mobilized) and ligamentous (defined or cut). On the right side the uterine tube and the round ligament have been cut near the uterus, the structures superior to the tube shown in detail—the contents of this whole ligament now being of chief interest, in their interrelationships. The uterine tube and round ligament have been removed except at their uterine extremity. The thinner part of the parametrium dissected away to expose the cut margins (the arrows) of the heavier tissue, which houses the uterine vessels; thus is shown the thickened basal part of the parametrium which becomes the cardinal ligament. On the left side, for purposes of comparison, only part of the fibrous tissue has been removed; the difference between tissue superior and inferior to the cervix is made evident.

But beginning with the level of the broad ligament branch of the uterine vein the general tissue lodged between the leaves of the broad ligament becomes tenacious and is continuous basally with the even tougher fibrous material of the cardinal ligaments (see hereinafter). In this lower half of each broad ligament the entire collection of tissue is thus separable into an exceedingly thin areolar layer immediately subserous in position and a more tenacious fibrous matrix in which the uterine veins and arteries are placed. Since the fibrous vascular sheath is so closely associated with the true supports of the uterus, it will be discussed under the heading of

Ligamentous Structures. On the cervix of the uterus posteriorly the subserous layer is inconsiderable, separating the collar of endopelvic fascia from the peritoneum. In front, as mentioned above, it is resistant, fastening the fascial covering of the cervix and the vagina to that of the bladder.

Rectal part. Although the uterus and vagina are in contact with the urinary bladder, they are close to the intestinal tube only in the latter's terminal portion. Situated in the posterior part of the lesser pelvis, the rectum is closely applied to the surface of the sacrum and coccyx following their concavity. In its upper two-thirds the rectum is invested by

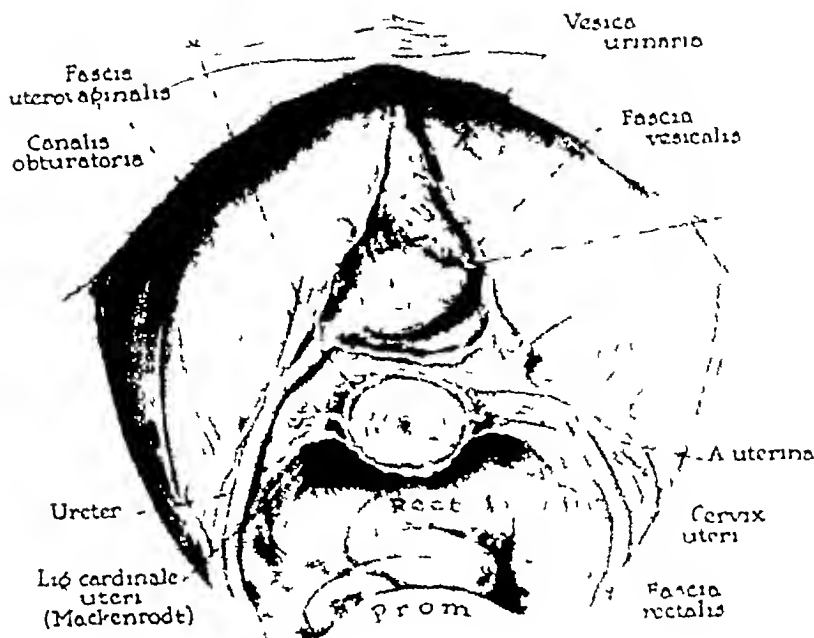


Fig 6 Broad ligament basal structures. Ligamentous supports of bladder and uterus and fascial coats of pelvic organs. In the midportion of the pelvis, on the right the uterine vessels have been excised, the remainder of the cardinal ligament retained for comparison with the structures exposed by deeper dissection on the left. On the left side the veins have been cut near their point of emergence from the uterine wall where they form a pedicle, elongated vertically. The ureter is shown in its surgically important relation to the uterine artery, and to the fused fascial sleeves of the bladder and vagina. The vesical artery has been retained.

In the anterior part of the pelvic cavity on the right side the fascial covering of the bladder has been partially stripped away, leaving the muscular coat exposed on the superior surface. On the left side the vesical layer of the endopelvic fascia has been freed, and that part of the bladder has been drawn toward the right in order to demonstrate the continuity of the diaphragmatic fascia and the vesical fascia. The fascia of the pelvic diaphragm is now clearly revealed, together with its upward directed vesical and uterine collars.

peritoneum on the anterior and the lateral surfaces, and is therefore separated from the uterus by the space of the recto-uterine pouch. But below the peritoneal level the intestinal tube is imbedded in the subserous connective tissue to a point just beyond the tip of the coccyx, where, continuing as the anal canal, it makes a sharp angle with the rectum and pierces the pelvic diaphragm. Only in the retroperitoneal part of its course is the rectum related to the vagina, their fascial collars, derived from the superior fascia of the pelvic diaphragm, being close together. Here the

tissue of the contiguous fascial investments is not fused to form "ligaments" corresponding to the "pillars" of the bladder. The organs may be mobilized readily, since a seam of areolar consistency separates adjacent surfaces of their fascial envelopes (see "Endopelvic Fascia", hereinafter). The fascial envelopes, with intervening cellular tissue, make up the "rectovaginal septum" of standard descriptions.

III. LIGAMENTOUS STRUCTURES

From even a cursory reading of the anatomical and surgical descriptions of the "liga-

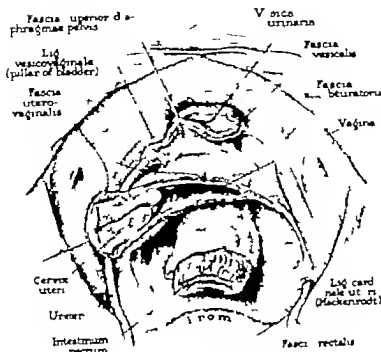


Fig. 7. Endopelvic fascia (visceral investments); ligamentous supports of the uterus. The bladder has been cut down to the trigonal portion, the lig. however the ureter on the left side. The cervix of the uterus and the vagina (upper portion) has been halved sagittally; the teres collar of endopelvic fascia separated from the muscular wall. On the right side a similar continuity is demonstrated—as is the relation of the fascial collar to the cardinal ligament. By drawing apart the bladder and the uterus, the fusion of their adjacent collars (laterally the fœtus protractus ligamentous connection) is evident. The lower fascial collar of the rectum is also mobilized.

ments" of the pelvis it is evident that current accounts require elucidation if not drastic revision. The conventional listing of peritoneal folds, obliterated vessels and ducts, fascial bands and heavy fibrous bands as ligaments presents the student and practitioner with a confusing list of supports which actually are very different in structure and consequently unlike in function.

Ligamentous support of bladder. The reflections of the peritoneum from the superior surface of the bladder to the walls of the pelvis are, according to Morris, sometimes described as the superior lateral and posterior *false ligaments*. Additionally there extends from the apex of the bladder to the umbilicus a fibrous cord, the remains of the embryonic allantois, which is termed the middle umbilical ligament of the bladder. In addition to these structures

certain thickenings of the endopelvic fascia, here it comes into relation with the bladder constitute what are termed the *true ligaments*. Two such thickenings are said to extend, in the female, from the lower part of the anterior aspect of the bladder to the pubic bone and constitute the middle pubovesical ligaments, with which muscle fibers (musculus pubovesicalis) are usually associated.

It seems entirely without reason to term a ligament even though recorded as a false ligament a simple reflection of the peritoneum; the employment of the term is misleading since the peritoneum lends only such support to the urinary bladder as it would to any retroperitoneal viscus. Similarly the adult remnant of the allantoic duct, being little more than a group of fibrils sometimes scarcely discoverable in the subperito-

al tissue of the anterior abdominal wall, does not merit designation as a ligament

Yet the bladder possesses an effective support in the fascial covering which it receives from the superior surface of the pelvic diaphragm, wing-like elevations of the fascial envelope (assumedly the pubovesical ligaments) offer special support, as do areas of fusion of the vesical with the vaginal collar of fascia (see "pillars of bladder," hereinafter) It should be further noted that these areas of continuity, together with the ligamentous extensions of the vagina and uterus form a serial group of connections which hold the organs in apposition between the pubis and sacrum

Ligamentous supports of uterus and vagina In addition to anchorage offered by the uterine tubes above and the vagina below, the uterus is described in textbooks of anatomy as possessing eight other important connections. Certain of these are merely peritoneal folds passing from the uterus to neighboring structures, while others are subperitoneal bands of connective tissue and smooth muscle. By some authors, in spite of the differences in character, all of these supports are placed in the category of "ligament," and are said to be eight in number: one anterior, one posterior, two round ligaments, two lateral or broad, two uterosacral

The anterior ligament consists simply of the peritoneum, which is reflected on the superior surface of the bladder from the anterior surface of the uterus

The posterior ligament consists of the fold of peritoneum which is reflected from the back of the posterior fornix of the vagina to the front of the rectum, this is elevated bilaterally to form two crescentic folds of peritoneum, named the sacrogenital or rectouterine folds, these pass backward from the cervix, on either side of the rectum, to the posterior wall of the pelvis. They contain a considerable amount of fibrous tissue and smooth muscle fibers and constitute the uterosacral ligaments (see below)

The lateral or broad ligaments are wing-like in form and consist, on each side, of a transverse duplicature of the pelvic peritoneum. Through much of their extent the apposed peritoneal layers lie close to each other, but laterally and inferiorly they deviate, going over into the parietal peritoneum on the lateral wall of the pelvis, and being reflected upon the bladder in front and the rectum behind. The areolar contents have been already described, the special nature of the vascular compartments and of the cardinal and uterosacral ligaments which lie at the base of the broad "ligament" will be discussed presently

The round ligaments are described by Cunningham as flat, cord-like bundles of fibers, by Spalteholz

the round ligament is described as a rounded smooth cord as large as a goose quill. In structure, it is described by Gray and Spalteholz as consisting of connective tissue and smooth muscle, by Cunningham as containing, at the uterine end, smooth muscle fibers continuous with those of the wall of the uterus, and more laterally consisting chiefly of fibrous tissue, this description is repeated, in substance, by Piersol. Traversing the inguinal canal, and carrying ahead of it a few fascicles of the internal oblique muscle, it appears at the abdominal inguinal ring in the substance of the mons pubis. Finally, according to the various authorities, it may terminate in the fatty subcutaneous tissue of the mons, spread out in a number of diverging fibrous bands which are attached in part to the periphery of the ring or may become fixed to the front of the pubic symphysis.

The uterosacral ligaments lie within plicæ of crescentic form, termed the recto-uterine (or sacrogenital) folds of peritoneum, the folds themselves form the lateral boundary of the recto-uterine pouch. It has become customary in gross anatomy to regard the entire content as divisible into two sets of bundles: (1) those which pass from the upper part of the cervix to the sides of the sacrum opposite the lower border of the sacroiliac articulation, to constitute the uterosacral ligament, (2) those groups of fibers which extend from the uterine cervix to the anterior surface of the sacrum and to the rectum and make up the recto-uterine muscles, at their uterine extremity, the muscular bands of the two sides, continuous with each other behind the cervix, form a transverse elevation, the *torus uterinus*.

The transverse cervical ligaments (Mackenrodt) are not recognized in gross anatomy. These ligaments are frequently discussed in medical journals and textbooks, yet, aside from Mackenrodt's original account, correct in essentials but not supported by anatomical dissections, nothing more than a vague description of these structures is discoverable in the general literature.

Anterior ligament This so called anterior ligament is merely the peritoneal investment of the uterus, and it possesses none of the anatomical features of a ligament, it is supportive only to the degree that any serous layer would be where it passes between adjacent viscera, in this instance the serosa contains no specially thickened fibrous elements.

Posterior ligaments The posterior ligaments are similarly peritoneal, but differ from the anterior in being elevated, as crescentic folds, over musculo-fibrous tissue of the uterosacral ligaments (see hereinafter).

Broad (lateral) ligaments These belong in the same category. Primarily peritoneal, the broad ligaments also consist of certain

structures placed between the serous folds.¹ Of these contents, the contained parametrial tissue and visceral blood vessels now call for discussion the round ligaments will receive consideration under a separate heading.

The loosely areolar cobwebby material encountered between the layers of the broad ligaments appears as a definite layer of areolar tissue, so thin that, when the investing peritoneum is removed, it drops away anteriorly to form a depression of roughly triangular outline (Fig. 3). The superior boundary of the area of thin parametrium is the uterine tube the inferior boundary is a ridge which, by palpation, even before dissection, is discovered to contain the obliquely coursing broad ligament branch of the uterine vein (Figs. 4-5) this vein marks the site of the upper border of a vascular compartment which encases also the somewhat more inferiorly placed transversely coursing uterine artery and accompanying vein (the vein accompanying the artery lies immediately beneath it, not exposed in this dissection). Near the uterus, parallel with it, are the ascending and descending branches of the artery (Fig. 5).

Since, in surgery the walls of the vascular sheath with the contained uterine vessels appear as a considerable mass continuous with the subjacent heavy ligament, it has become customary to consider the entire assemblage as the cardinal (transverse cervical, Mackenrodt) ligament.

From the top of the vascular compartment downward the parametrium thickens and consists of two definite layers posteriorly it is continuous with the uterosacral ligament the latter is blended in turn with the more dense portion of the cardinal ligament (exposed on the right, Fig. 4, by the removal of the uterosacral ligament) so intimate is the connection of the two that segregation is rather artificial. An explanation for the valuable support to the uterus obtained by suturing together the uterosacral ligaments with silk is now apparent.

Actually the broad ligament, so called, is a mesenterial support of modified form, which not only invests a viscous and its ducts and transmits vessels and nerves within a special sheath, but also contains true ligaments of both anterior abdominal and posterior pelvic attachments these are the round the uterosacral, and the cardinal ligaments—which structures will now be described.

Round ligaments. Just as, in a posterior direction, the peritoneum is lifted by presence of subjacent uterosacral ligaments, so in an anterior direction it is elevated by round ligaments en route to abdominal wall.

In careful removal of the anterior peritoneal layer of the broad ligament, the elevation apparent immediately below the uterine tube (Fig. 1 observer's right) is found to be produced by the superior margin of the round ligament (cf. Fig. 1 left).

Near the uterus, the round ligaments are found to be flat bands, not round cords. Each ligament is inserted broadly into the uterus, spread out in its attachment to the uterine musculature in a manner analogous to the spread of the pectoralis muscles on the chest, the attachment to the uterus extending obliquely downward to the level of the uppermost uterine vein, described later (Figs. 3-4). At the uterine extremity of the ligament, for a distance of 3-5 centimeters, the peritoneum dissects away from the ligament with difficulty. This suggests that some of the externally placed muscle fibers of the round ligament insert directly into the peritoneum, much as do the muscle fibers of the upper corpus. Becoming more fibrous and narrowing as it passes anterolaterally the ligament finally becomes imbedded in the more abundant areolar tissue existing near the pelvic wall. Within the inguinal canal the round ligament diminishes gradually in caliber yet it may be considered to be firmly anchored to the abdominal wall, through whose layers it passes to the subcutaneous inguinal ring. In emerging from the ring, the ligament is frequently no thicker than a violin string, sometimes so small in the dissected body as to be scarcely discoverable.²

¹Obviously "fold" (plica) would be more suitable than "ligament" in covering these lateral displacements of the pelvic peritoneum, but old custom in anatomy and surgery however (typical their misstatement may be, are usually persistent). Were structures termed "round folds," that no personified place they would contain true ligaments, the round and the cardinal ligaments, just as the vesico-vaginal folds contain the uterosacral ligaments.

²Externally round ligament is contained in subcutaneous of superficial fascia, directed downward into labium (Amos, *Med. et Anat. Rec.*, 1924, 72, 404).

The inferomedial limit of the round ligament marks the point at which the superior edge of the fascial investment of the uterus is definable grossly (cf Fig 6) it may therefore be stated that over an area of 2 centimeters or more on the anterior surface of the uterus the round ligament is continuous with the superior margin of the heavy fascial collar which invests the vagina and the lower portion of the uterus, in other words, in front, the uterus is supported superiorly by the round ligaments and inferiorly by the special collar derived from the endopelvic fascia. A hitherto inexplicable clinical observation is herewith elucidated, it has been noted that patients with marked retrodisplacement of the uterus are prone to have a low location or "skidding" downward of the bladder in relation to the uterus, also, "advancement of the peritoneal reflection," placing the vesico-uterine fold and bladder higher upon the uterus, has afforded surprising support in the operative correction of retrodisplacements, an explanation is offered in the support afforded by the vesical collar, which by this procedure is attached more intimately and at a higher level on the uterus.

Uterosacral ligaments Stretching away from the posterolateral aspect of the uterus on each side of the pelvic cavity is a uterosacral ligament (Figs 3, 4, and 5), beneath its peritoneal covering it forms the lateral boundary of the pararectal fossa at the latter's superior plane (Fig 3, left side).

The uterosacral bands are true ligaments, they contain, as regularly described, connective tissue and smooth muscle arranged in "robust bands", but the latter are not, according to the observations of the present authors, arranged as separable muscles.

Freed of its serous investment, the uterosacral ligament forms a prominently jutting ligament-like ridge at its uterine extremity, whereas the sacral extremity is of such even contour that it bears little resemblance to a true ligamentous band. The uterosacral ligaments are of musculofascial consistency, resembling the round ligaments in this respect. Above, the ligament is continuous with the posterior leaf of the vascular compartment, the connecting bridge, though more condensed than areolar tissue, is not particularly firm.

The lateral margin of the ligament is continuous with the adjacent posterior firm layer of the Mackenrodt ligament.

In consideration of the fact that the uterosacral ligament is blended lateralward as a unit with the Mackenrodt ligament (Figs 3, 4, and 5), the confusion which has existed relative to the support afforded by the uterosacral ligaments should now be clarified, forming the medial border of, and integrated with, the Mackenrodt ligament, division of the uterosacral ligament and the adjacent parametrium releases uterine fixation and support proportional to the extent to which the scissors cut transversely lateralward through these tissues.

Cardinal or transverse cervical ligaments (of Mackenrodt) When the uterosacral ligaments are removed the heavier adjacent structure with which they are continuous, which remains on each side, is the Mackenrodt (cardinal) ligament of the uterus. Included with this is the definite fibrous sheath covering the vessels (Fig 5). This vascular compartment suggests in general structure the covering of the carotid or the femoral vessels, but it differs from these investments in being situated at the apex of a triangular septum of heavy fibrous tissue. The vascular "core" consists of the uterine artery and veins with their immediate investitures, placed essentially transversely in the base of the broad ligament, the uppermost vessel is a uterine vein, obliquely traversing the broad ligament at the level which marks the superior border of the fascial collar of the uterus. The fascial collar may be considered as continuous with the walls of the vascular compartment, since extensions of the fascia accompany the ascending and descending branches of the vessels in their distribution along the uterus and vagina. The sheath of the vascular compartment may be separated from the vessels, when cut at the upper margin (Fig 5, right) it resembled an envelope trimmed along its superior edge and opened.

The entire mass of tissue constituting Mackenrodt's ligament spreads tent-like lateralward toward the pelvic wall, to become inserted fan-shaped into the fascia overlying the obturator muscle and the superior fascia of the pelvic diaphragm, it also merges medially and inferiorly into the uterovaginal

and vesical fascial envelopes, and is integrated posteriorly with the uterosacral ligament.

Upon both gross and microscopical study including special differential stains, it appears that there is a limited number of muscle fibers in the Mackenrodt ligaments, other than those encountered in the walls of the blood vessels in this exceedingly vascular tissue. The tensile strength and elasticity of the upper parametrical portion of Mackenrodt's ligaments is evidently ascribable in large measure to the connective tissue components of the walls of the veins and the unusually abundant connective tissue accompanying the blood vessels. A proper appreciation of the venous supply of this tissue is best obtained by observations at operation after surgical dissection of the overlying peritoneum, integrated with microscopical study of selected material removed together with the uterus.

The authors are in accord with the opinion of Mengert, whose experiments indicated that the Mackenrodt ligaments, and their perivaginal continuations, are the chief supports of the uterus.

Ligamentous supports of rectum. The uterosacral (peritoneal) folds, mentioned previously in connection with the ligaments of the bladder are sometimes reckoned among the supports of the rectum. The peritoneal folds contain fibrous tissue, their free edges are semilunar and sharp, they curve around the rectum above the ampulla, which they partially roof in (Piersol).

Except for its peritoneal investment and the hemorrhoidal vessels, the rectum, in so far as observed in the present study is without special ligamentous supports; the rectouterine muscles, often described as part of the uterosacral ligaments, were not seen by the present authors. But through its continuity with the anal canal—which is firmly fixed to the pelvic floor—the rectum is anchored at its termination; further stability is gained through the presence of the fascial collar derived from the superior layer of the pelvic diaphragm (see hereinafter).

IV. ENDOPELVIC FASCIA

The fascial covering of the pelvic muscles is regularly described as being carried upward on the viscera as the latter pierce the pelvic diaphragm to reach the exterior. But, as here recorded, the conventional descriptions draw no careful distinction between fascia, parametrium, and ligament. In current dissections the collars derived from the pelvic fascia were found to be exceptionally definite structures that could be freed from the lateral tissue

of each organ and from the general extraperitoneal layer.

Vesical part. As already pointed out, on the urinary bladder and especially near the lateral margin (superior view) the subperitoneal areolar tissue is a definite layer as readily demonstrable as it is in the upper part of the broad ligament. Locally thinned over the middle area of the superior surface of the bladder it blends with the fascial sheath of the bladder (vesical layer of the endopelvic fascia). At the meeting point of the inferolateral and superior surfaces, the layer is carried upward upon the wall of the true pelvis as a wing-like leaf (Fig. 2). This arrangement is regularly seen in the dissecting room, where upon reflecting the peritoneum, the margins of the bladder seem prolonged superolaterally. In the iliac fossa, over the iliac fascia, the layer becomes cobweb-like in texture and is no longer a readily dissectable stratum. At the sides of the bladder between the latter and the pelvic diaphragm, the layer assumes the form of a characterless packing, and is easily dissectable with the finger.

In transition from the uterus to the bladder the subserous tissue increases in thickness and density and merges into the vesical collar of the endopelvic fascia (Fig. 2). To each side of the lateral margin of the bladder the thickened subserous cellular tissue is attached in such a way that the true triangular outline of the organ is masked when dissected from above; it is found that these upward directed wings finally become the inconsiderable stratum of fatty areolar tissue which intervenes between the peritoneum and the iliac fascia in the greater pelvis at the pelvic brim, between the greater and the lesser pelvis, a continuation of this same tissue forms the housing for the iliac vessels. In it, anteriorly the middle and lateral umbilical ligaments are imbedded while posteriorly it contributes to the fibrous substance of the infundibulopelvic or suspensory ligament of the ovary and constitutes the layer in which the aorta and the inferior vena cava are situated.

Over the superior surface of the urinary bladder the tela subserosa merges with the vesical layer of the endopelvic fascia, which

here, is exceedingly thin. But the vesical fascia is prominent on the inferolateral surfaces, carried outward inferiorly as the superior fascia of the pelvic diaphragm (Fig 6). When cut, it appears as a definite "collar." In being carried lateralward and upward at the pelvic floor, except anteriorly, the endopelvic layer does *not* descend to the point at which the urethra pierces the urogenital diaphragm, it sweeps toward the pelvic diaphragm at a relatively high level, its width is therefore much greater than the width of the urethra, being 3.0 centimeters wide. This means that the urethra itself lies within a subfascial partition (formed by continuity of visceral and diaphragmatic parts of the pelvic lining). As established by the earlier series of dissections (Curtis, Anson, and McVay, 1939), the urethra receives an investment from the structure next below, namely the urogenital diaphragm.

The urinary bladder can be rather readily enucleated from the fascial envelope in which it is housed (Fig 6), like the outline of the viscus itself this fascial covering is triangular in outline, the base situated posteriorly, against the cervix and vagina, the apex pointed anteriorly toward the pubic symphysis. In becoming continuous with the superior fascia of the pelvic diaphragm the layer is lifted into a wing-like fold similar to that which is related to the vagina.

As the tela subserosa is removed from the region between the bladder and vagina, it is found to become denser, less similar to a true subperitoneal tissue, as the pelvic floor is approached. Near the point where the vesical and vaginal fascial collars arise by being carried upward upon the organs, the intervening subserous tissue is so distinctly fibrous in nature that the fascial coverings are difficult to separate. So strong is the fusion that bilateral connecting bands are formed, these are the "pillars of the bladder" (Fig 7). At this point, mention of a surgical landmark may not be amiss: the ureters are situated immediately above (anterior to) and 1 centimeter lateral to the bladder pillars.

Uterovaginal part. It has already been stated that the fascial covering of the vagina and uterus sweeps upward from the pelvic floor, encas-

ing these tubular structures (see Curtis, Anson, and McVay, Fig 1), it is likewise established that these tubular collars thin out as they ascend, becoming such an inconsiderable layer over the body and the fundus of the uterus that the peritoneum seemingly lies directly upon the muscular coat of the organ (Figs 2, 3, and 4). Proceeding downward, it is at the approximate line of junction of the body and the cervix of the uterus that the fascial collar first becomes definable, this is the level at which the round ligaments (Figs 1 and 2) and the uterosacral and the cardinal ligaments (Figs 3, 4, and 5) are attached to the uterus. Inferior to this level the uterine "collar" of fascia becomes distinct and can be separated from the muscular coat, it becomes thicker as it invests the cervix (Fig 6) where it is the strongest of the three tubes of the endopelvic fascia. In general terms it might be described as being pierced by the uterine vessels along each lateral margin of the uterus (Fig 6, cf Fig 5), actually, its tissue is prolonged upon these vessels as a sheath and is continuous lateralward with Mackenrodt's ligament.

Inferiorly, the thick collar covering the cervix is readily traceable upon the vagina, separable from the latter's intrinsic musculature (Fig 7), extending lateralward and backward, it is continuous with the basal portion of the parametrium, at the level of the pelvic floor it spreads out as the superior fascia of the pelvic diaphragm. In form, the vaginal collar is wing-like, similar in character to that figured for the bladder in the earlier set of drawings (Curtis, Anson, and McVay, 1939, Fig 1), it is prominent in dissection and exceptionally strong, yet it has not been described in gross anatomy. These wing-like fascial bands follow the inclination of the vagina, their forward inclination accounts in part for the capaciousness of the recto-uterine recess (Fig 7, cf Figs 3 and 5).

Since the course of the ureters is a matter of surpassing importance in surgery of the pelvic organs, comment upon their anatomical relations to neighboring structures seems warranted. At the brim of the lesser pelvis each ureter lies immediately medial to the attachment of the infundibulopelvic (suspensory) ligament, exactly in the region where

the ligament is clamped and divided in those cases in which the ovary is removed at hysterectomy. Therefore in peritonization following removal of the uterus and the ovaries, the ureter is dangerously near the lateral limit of the surgical field, and the peritonizing suture should never be deeply placed without preliminary palpation of the ureter. The ureters converge as they approach the bladder; therefore, while each is located 4 centimeters from the uterus at the level of the internal os, the ureter is only 1.5 centimeters from the lowermost portion of the cervix at the point of closest proximity. As has become clear from the discussion, the ureters in their downward course, lie beneath the tent-like lateral extensions of Mackenrodt's ligaments, and pass under the uterine vessels (Fig. 6). At the level at which the pelvic surgeon usually places clamps on the vagina in performing a simple complete hysterectomy the ureters are approximately 8 centimeters apart. As the ureters approach the bladder they are situated just anterior and 1 centimeter lateral to the pillars of the bladder; the ureter is imbedded in heavy fibrous tissue which is prolonged upon it from the musculofascial covering of the bladder—a structural fact important in radical hysterectomy for cancer. In this fibrous investment pass the ureteral lymphatics creating a pathway for drainage from the cellular tissue contained within Mackenrodt's ligament.

In summary, it may be said that the vaginouterine collar (especially in its strong cervical portion) serves as anchorage for the uterus,

since into it insert not only the prominent ligaments of sacral attachment, but also, bilaterally the thickened parametrial tents, or Mackenrodt ligaments, including the vessels contained therein. There are also the anteriorly placed supports which have been described in connection with the urinary bladder; these are produced through local fusion of the adjacent surfaces of the uterine and vesical collars of endopelvic fascia.

Rectal part. The rectum possesses a very definite fascial collar readily separable from the muscular coat of the tube. It is a loose investment, thinner than the corresponding coverings of the bladder and the uterus (Fig. 7).

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ANESTHESIA IN CESAREAN SECTION

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IN the rather scanty literature on cesarean section very little mention is made of the anesthetic and even less of its effect upon the respirations of the infant. When artificial respiration is needed or pneumonia follows initial respiratory difficulties, it is too often dismissed as due to toxemia or other ill health in the mother. In reality, the type of anesthetic used for the operation plays a very definite part in the baby's start in life. No form of anesthesia nor method of resuscitation will save a baby with very marked defect of brain or heart. It is doomed by congenital defects for which there is no remedy. Many others, however, fail to survive the first few hours because their respiratory mechanism is unable to function properly, due to depression by the anesthetic or sedative. It is impossible to anesthetize or sedate the mother by inhalation or narcotics without anesthetizing the fetus. The drug is absorbed at the time when the fetal respiratory and cardiac centers are at their lowest ebb following prolonged labor or damage secondary to maternal ill health. Most babies, particularly if the operation is at the time of election, will withstand this terminal depression and breathe spontaneously. The occasional one, however, is unable to cope with the depressing effect of the anesthetic and breathes only after resuscitation. Too often the respirations remain unsatisfactory and atelectasis leads to pneumonia or death. Since it is impossible to predict in advance the exact state of the respiratory system, safety demands the use of the anesthetic which will add least strain to the already overburdened fetus. The anesthesia in question in this series proved to be spinal with straight cyclopropane-oxygen, or nitrous oxide-oxygen without ether a close second. Ether is definitely contra-indicated particularly after a heavy sedative.

In a previous publication (2) it was shown that with spinal anesthesia the babies breathed much better than with nitrous oxide-oxygen.

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ether. Since then, general anesthesia has been revolutionized by the introduction of cyclopropane and the carbon dioxide absorption technique for all gases (1, 3). Meanwhile, spinal anesthesia has remained at a standstill. Results with this type of anesthesia are as striking as ever and it remains the anesthetic of choice, but the newer methods of general anesthesia present so much keener competition that it is no longer necessary to force spinal anesthesia on a patient or surgeon who objects to it. It cannot be emphasized too strongly that the alternative for spinal anesthesia is either cyclopropane or nitrous oxide alone without ether. Ether, by itself or added to these gases, is very definitely depressing to the fetus and should be used only after the most careful consideration of the relative merits of spinal anesthesia. These statements are based on an analysis of the 279 cesarean sections performed in St. Michael's Hospital, Toronto, in the past 8 years. This represents 1.9 operations per 100 normal deliveries and indicates the use of conservative surgery with an inevitably high incidence of difficulties. Further, 109 mothers were in abnormal health and 157 were in active labor 4 to 72 hours. Ages ranged from 15 to 48. Almost one-third of the patients returned a second, third, or even fourth time, and 65 individuals accounted for 141 babies. This repetition of operation suggests matching the anesthetic to the patient's condition so that she will not approach a later operation in dread of it. The causes of operation were simple contracted pelvis, 170; abnormal health in mother, 109. Of the unhealthy mothers, 78 had ample pelvic measurements but the condition was serious enough for pregnancy to be terminated by section instead of delivery.

In this unselected series the anesthetics used were spinal, 141 or 50.6 per cent, cyclopropane or nitrous oxide, 70 or 25.1 per cent, ether, alone or with cyclopropane or nitrous oxide, 65 or 23.2 per cent, local 2, and pentothal 1. The rôle of each type can be deter-

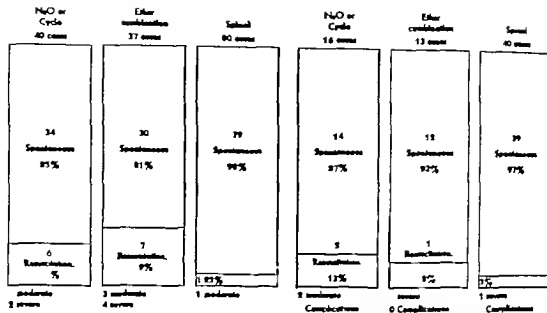


Chart 2. Infant respirations in 57 cases. Mother and baby both normal. Mother in good health with contracted pelvis or previous cesarean. Baby at term with no congenital defect, clinically or at autopsy.

mined only in conjunction with a consideration of the health of the mother and child upon whom it is used. The effect of one anesthetic on the premature baby of an eclamptic mother should not be set against the record of a different anesthetic on the fully developed infant of a healthy mother. To avoid this error the series has been divided into 4 comparable groups, depending on the condition of the mother and fetus. Chart 1 deals with 157 normal mothers in good health, with simple contracted pelvis or histories of previous sections, who produced normal babies at full term with no defects clinically or at autopsy. With gas alone 85 per cent of the babies breathed spontaneously i.e. in less than 2 minutes, with no more manipulation than was necessary for the proper clearing of the air passages of mucus or foreign material. In 15 per cent resuscitation was needed such as artificial respiration, oxygen, hot baths, coramine, etc. With ether alone or in combination the results were numerically similar 19 per cent required resuscitation, but the results actually were not so satisfactory because 4 of these were re-

Chart 1. Infant respirations in 60 cases with mother abnormal—tension, eclamptic convulsions; prolonged labor 4 to 7 hours, pyrexia, cardiac decompensation; placenta previa and hemorrhage; upper respiratory infection, earache, nephritis, syphilis, epkopy, diabetes, toxemia, gonorrhea, fibroids, ovarian cyst. Baby normal at term with no congenital defect.

vived with great difficulty and 1 died in 5 hours. With spinal anesthesia in 80 cases only 1 baby required resuscitation. Most of these babies breathe before the feet are out of the incision and cry lustily before the cord is cut. The difference between the baby born with spinal anesthesia and one when ether was employed must be seen to be appreciated. Even in the case when cyclopropane has been administered the baby does not approach in rapidity of response the one which was born with the aid of spinal anesthesia particularly if a sedative has preceded operation. These were normal babies and this good condition of the fetus has apparently a greater bearing on respirations than has the health of the mother.

This is proved in Chart 2. Sixty-nine normal babies were produced by mothers in abnormal health, many of whom were in the advanced stages of the diseases indicated. In view of the maternal handicap, the results are rather surprising. With gas, 12.5 per cent of the newborn were resuscitated with ether

76 per cent, and with spinal anesthesia in 40 cases—again the equal of the others combined—only 1 needed resuscitation. While this is definitely favorable to spinal anesthesia, the lack of complications in the entire group seems to indicate that the normal baby does well with almost any procedure.

This is confirmed by Chart 3 which deals with the opposite group of abnormal babies, in which complications were very high despite the good health of the normal mother. Percentages are inaccurate in such a small number, namely, 13 patients, but the bad record of ether cannot be contradicted. In 7 cases, 6 babies were resuscitated and 2 died within 5 hours. Spinal and gas were equal with 1 resuscitation each but without complications.

Again in Chart 4, with 40 abnormal babies and abnormal mothers the complications were very high. Both mother and child were unhealthy, each had one or more of the major obstetrical disorders. This proved to be a disastrous combination with any anesthetic. Forty cases showed 11 deaths from atelectasis superimposed on existing defects. In addition there were 3 stillbirths, the fetus had been delivered without heart beat and had been dead or dying before the commencement of operation. Again the poor result with ether is seen. In 8 cases, 6 were resuscitated and 4 died within 12 hours. Gas and spinal anesthesia were equal with 27 per cent resuscitations and 2 and 3 deaths, respectively. Local and pentothal anesthesia were used only in profound toxemia or hemorrhage with upper respiratory infection. The mothers did well but 2 babies died, both premature infants weighed 3½ and 4 pounds, respectively.

Thus the advantageous effect of spinal anesthesia upon the baby cannot be questioned but it is the opinion of the gynecologists concerned that the postoperative course in the mother is not as smooth as after general anesthesia. Hence, with the introduction of cyclopropane there has been a trend toward it, spinal anesthesia is reserved for specific indications. This is at variance with the experience on general surgical services where, during the same 8 year period, 66 per cent of all abdominal work has been done with spinal anesthesia. The popularity of spinal

N ₂ O or Cyclo 3 cases	Ether combination 7 cases	Spinal 3 cases
2 Spontaneous 66%	1 Spontaneous 15%	2 Spontaneous 66%
1 Resuscitation 33%	6 Resuscitation 85%	1 Resuscitation 33%
1 severe	4 moderate 2 severe	1 severe
0 Complications	2 Died—atelectasis	0 Complications

Chart 3 Infant respirations in 13 cases with normal mother—in good health with contracted pelvis and baby abnormal with following complications: prematurity, 6 to 8½ months, underweight, 2½ pounds up, hydrocephalus, spina bifida, hare lip, cleft palate, head injury, large thymus, twins, cardiac distress.

anesthesia in general surgery has been only moderately influenced by the introduction of cyclopropane, since the use of spinal anesthesia in 63 per cent of all abdominal surgery for 1938 represents only a small drop from the peak of 73 per cent in 1935.

However, the opposition to spinal anesthesia in the pregnant woman is quite widespread in many centers. The risk of low blood pressure, particularly if hemorrhage be superimposed on the initial drop, is frequently cited. Against this must be balanced the hazards of general anesthesia, namely, obstruction of the air passages, aspiration of vomitus in the unprepared emergency case, improper aeration of the lungs due to pressure from below, and damage by the anesthetic agent to the already weakened organs and tissues. These may imperil the patient quite as much as the more dramatic circulatory depression of spinal anesthesia. The one group probably offsets the other in any large series in which the surgical risk varies so widely with maternal health. One case of spinal shock was postponed and next day

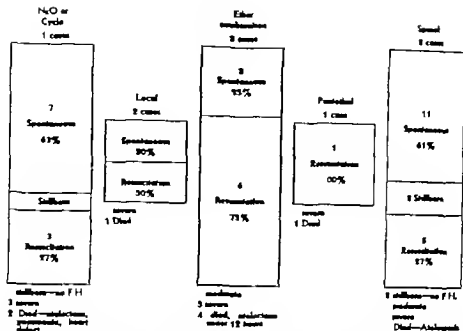


Chart 4. Infant respirations in 40 cases. 1 lb mother and baby both abnormal, the mother showing following complications: toxemia, eclamptic convulsions, prolonged labor 24-36 hours; pyelitis; cardiac decompensation; placenta previa and hemorrhage; upper respiratory infection, carcinoma, nephritis, syphilis, epilepsy, diabetes; asthma, gonorrhea, fibroids, tuberculosis. The complications in baby are prolapsed cord, twin prematurity 7 to 8 months, underweight, 14 pounds up hydrocephalus, epina bifida, cleft palate, head injury, large thymus, cardiac distress.

handled well with nitrous oxide. One patient did badly with cyclopropane and ether but a week later responded well to spinal anesthesia.

It is frequently stated that the possibility of excessively high anesthesia is greater in pregnancy than in normal health because of altered dynamics of intra-abdominal pressure and cir-

culation. High anesthesia with paralysis of the intercostal muscles and occasionally the diaphragm is a real danger in any spinal anesthetic. It calls for the immediate administration of oxygen, possibly with artificial respiration, until the level of motor anesthesia has receded to a point at which the intercostals regain their respiratory function. During this same 8 year period in 8,472 operations with spinal anesthesia for all types of surgery this complication was encountered 20 times with 1 death. Two of these were cases of cesarean section. Despite the relatively high incidence of 2 in 279, careful study of all phases of spinal anesthesia, so widely used in St. Michael's Hospital, leads one to believe that probably this danger is no greater in pregnancy than in other conditions. Certainly spinal anesthesia has proved to be the best anesthetic in operations, such as appendectomy, which have been necessary in the course of pregnancy. In one of the cesarean sections, the intercostals alone were involved and after oxygen inhalations for

TABLE 2.—MATERNAL COMPLICATIONS—CARDIAC, RESPIRATORY CIRCULATORY

Anesthesia	Cases	Complications during operation		Complications after operation	
		Cases	Per cent	Cases	Per cent
Spinal	1,421	13		severe 14	1
				severe 3 death (cardiac)	
Ether, combination	89			severe 13	15
				severe 3 death (cardiac)	
Nitrous oxide or cyclopropane	30	6	20	severe 5 death (cardiac)	17
Local or partial					
Total	1,540	25	1.6	severe 34	2.2
				severe 3 death	

35 minutes she returned to bed and in an hour was smoking a cigarette. Next day cyclopropane was successfully used. Her first cesarean operation had been with spinal anesthesia 4 years previously without complication. In the other case of a toxic mother in advanced labor, the diaphragm was involved and artificial respiration was necessary for 25 minutes after which the operation was completed under the original spinal anesthetic. Collapse of the lung had occurred, however, and pneumonia was followed by pleurisy with effusion. Since then 2 additional cesareans have been satisfactorily done with general anesthesia.

Complications (Table I) during and after operation, involving the cardiac, respiratory, and circulatory systems are the only ones in which the anesthetist is qualified to express an opinion as to his responsibility. It will be seen that severe complications occur with each type of anesthesia and that the incidence does not vary greatly. With ether the complications after operation are 12.3 per cent while with the use of straight gas the complications during operation are 11.4 per cent. This is of great significance because even the best anesthetist encounters the occasional patient in whom satisfactory working conditions cannot be obtained without pushing nitrous oxide, or even cyclopropane, beyond the limits of safety. To complete the operation, ether must be added to the gas with the proved dangers to the baby. It is impossible to guarantee in advance that any gas anesthetic can be carried through without some ether. Actually, of the 65 cases classed as "ether combination" only 19 received ether from the start. The 46 remaining commenced with gas anesthesia but ended with sufficient ether to necessitate their transfer to the less safe category. On the other hand, with spinal anesthesia no supplemental inhalation was needed in any case until after the baby had been safely delivered. In 13

cases, or 9 per cent, gas was used to complete an unduly long operation.

SUMMARY

In the mother, pulmonary and cardiac complications are not markedly influenced by the type of anesthetic. This is in accordance with the now universally recognized fact that pulmonary complications vary primarily with the site of operation and length of time on the table. Consequently, the tendency will be for the surgeon or anesthetist to use the anesthetic which he prefers for ordinary abdominal work, such as hysterectomy. The man who dislikes spinal anesthesia in one will probably avoid it in the other. Perhaps this is not unreasonable, since there is an old dictum that the safest anesthetic is the one with which the individual is himself most adept. However, this must not be carelessly carried to the point of endangering the baby, whose safety demands the avoidance of ether. The bad effect of ether reaches its peak in the abnormal baby or with heavy sedation in the mother. Ether can be avoided simply and easily by the use of spinal anesthesia or, with much greater difficulty, by the use of gas alone. General anesthesia is best avoided unless the obstetrician is reasonably sure that the baby is normal and the anesthetist confident that he can complete the work with gas alone. He who denies the baby the safety of spinal anesthesia must accept the responsibility of protecting him from ether, for if this article is not to be interpreted as an argument for spinal anesthesia, it is at least a condemnation of ether.

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THE PROBLEM FOR SURGERY IN THE TREATMENT OF MASSIVE HEMORRHAGE OF ULCER ORIGIN

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THE subject of bleeding from gastroduodenal ulcer has received considerable attention in the recent literature. A number of foreign and American authors have reviewed their experiences in dealing with massive hemorrhage and have importantly demonstrated that this complication of peptic ulceration carries with it a greater hazard than had commonly been conceded. At the present time medical gastroenterologists are greatly concerned with reducing mortality rates from hemorrhage. Many men interested in the problem have turned to new forms of treatment and in some clinics the old well known, and time honored regimen commonly referred to as the "starvation treatment" has been replaced by newer procedures. Meulengracht (7-8) has introduced the practice of feeding patients with hemorrhage rather than depriving them of food and water. He reports marked success by this method of management and has reduced the death rate in his patients to a low figure of 1.8 per cent. If his results could be obtained by others, the problem of decreasing mortality from bleeding would be solved in great part. Crohn however reports that he has not met with the same success using Meulengracht's treatment. Other new forms of medical therapy that have gained some prominence in the treatment of active bleeding from ulcer are the use of aluminum hydroxide preparations introduced into the stomach constantly by gastric intubation (10) and the so called massive transfusion method described by Marriott and Kewwick. At the present time it can be said safely that none of these new procedures has proved to be greatly superior to the older starvation plan of therapy.

Whether or not surgery shall take a prominent part in the immediate treatment of hem-

orrhage from ulcer is a debatable point and warrants serious consideration. Ballfour (3), in summarizing the consensus of opinion held by most surgeons, advises against operation except under unusual circumstances. The factor of uncertainty of the diagnosis of ulcer in cases of massive bleeding is a not small consideration which increases the justifiable reluctance of surgeons to submit large numbers of patients to operation. Gradually however an increasing number of surgeons are advocating operative treatment for ulcer hemorrhage either as a measure for all patients in whom operation is possible or for selected groups. Finsterer has recommended early operation and believes that the best time for surgical intervention is within 48 hours after the beginning of hemorrhage. He reports reasonable mortality rates in the group of patients upon whom he has operated and he believes that in the use of surgery will be found the solution to mortality reduction for bleeding in patients with peptic ulcer. Gordon-Taylor in England, and more recently Pieflier in this country have made pleas for a more active interest on the part of surgeons in the problem of massive hemorrhage. Surgeons must give careful attention to those who advise operative measures and must decide whether or not they will engage in a surgical program for the immediate treatment of bleeding. The surgical method of treatment has an attractive offer to make since it proposes to stop bleeding completely and accurately. At the present time the indications for operation are not established nor have the available reports on operative treatment clearly demonstrated that mortality can be reduced by surgery. While a plan for operative treatment on a large scale in massive hemorrhage cannot be accepted too enthusiastically it cannot be rejected without careful study of the whole problem.

In order to estimate the seriousness of ulcer hemorrhage as it is seen in a general hospital,

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and to define the problem facing us, we have reviewed the records of patients with gastric or duodenal ulcer who have been treated for hemorrhage at the Albany Hospital during the past 9 years (1930 through 1938). In the hemorrhage group we included only those patients with either gastric or duodenal ulcer in whom there was definite bleeding of an acute nature with hematemesis, or tarry stools. The diagnosis of gastric or duodenal ulcer was substantiated by roentgenological examination in three-fourths of the patients in our series. In the other one-fourth no fluoroscopic examination of the gastro-intestinal tract was done. The diagnosis of these cases was accepted after careful appraisal of the clinical findings and course under treatment.

In all, there were 690 patients with peptic ulcer admitted to the Albany Hospital during the 9 year period of study. Duodenal ulcer was found to be four times more frequent than gastric ulcer. One hundred twenty-eight patients, or 18.6 per cent of the total 690, were admitted to the hospital because of bleeding. Hemorrhage was severe in two-thirds of the patients and mild in one-third. This classification was made on the basis of duration of bleeding episode, the severity of anemia, and the clinical condition of the patient. Only 17 of the 128 patients with hemorrhage proved to have gastric ulcer. In the 111 remaining patients, a diagnosis of duodenal ulcer was made. The incidence of bleeding among patients with gastric ulcer was found to be 11.6 per cent. In the case of those with duodenal ulcer, the hemorrhage incidence was 20.4 per cent.

There were 13 deaths among the 128 patients with ulcer hemorrhage, making a total mortality rate of 10.2 per cent. Except for 3 patients upon whom operation was performed to control hemorrhage, all were treated by a standard medical routine. At the Albany Hospital the conservative procedure has been one of preliminary starvation until obvious hemorrhage has ceased. Dehydration was combated by intravenous and subcutaneous infusions of saline. After hemorrhage seemed to have stopped, various modifications of the Sippy dietary regimen were followed.

There were 125 patients treated in this general manner with 11 deaths in the group, making

the mortality rate 8.8 per cent for patients treated by the conservative plan. We reviewed the clinical records of these 125 patients in an attempt to detect factors which might have some possible influence upon the gravity of hemorrhage. The duration of dyspeptic symptoms did not seem to have any bearing upon the mortality rate. A history of one or more previous hemorrhages was no more frequent among the patients who died than among those who survived. Of the 114 patients surviving 39.1 per cent had bled on one or more occasions before the present episode. Of the patients who died, 38.5 per cent gave a history of previous hemorrhage. The duration of hemorrhage before the patient came to the hospital varied widely but did not seem to have any direct bearing upon the mortality rate. It has been said that hemorrhage from ulcer among women is less serious than it is in men. Crohn encountered no deaths among the female patients whom he studied. There were 183 female patients with ulcer in our group comprised of 690 individuals. The incidence of hemorrhage among females was 14.2 per cent in contrast to a 20.1 per cent incidence in the males. The mortality rate among women was 7.7 per cent and among men was 10.8 per cent. The findings in our group would not seem to support the feeling that hemorrhage from ulcer in women is much less serious than in men. The mortality rate among patients with bleeding gastric ulcer was 35.3 per cent, a much higher figure than that found in those with bleeding duodenal ulcer (6.3 per cent). In this series it would seem that while the incidence of bleeding in cases with gastric ulcer is less than the incidence in duodenal ulcer, the mortality from hemorrhage is much greater. We found that previous surgical treatment seemed to protect the patient from fatal hemorrhage. Twenty-two patients, or 19.8 per cent of all patients with hemorrhage, had had posterior gastro-enterostomy performed previously. There were no deaths among these patients.

That age is an important factor in affecting mortality from ulcer hemorrhage has been emphasized by Allen and Benedict. In our investigation we have given the age factor particular study. After the age of 50, we found, as did

Allen and Benedict, that the incidence of death from hemorrhage abruptly increased. Of the 125 patients 75 were under the age of 50, and among these there was only 1 death, making the mortality rate 1.3 per cent. In the group beyond the age of 50 there were 50 patients and of these 10 died producing a death rate of 20 per cent. Further analysis revealed that mortality increased with each decade of life beyond the age of 50. Although hemorrhage tended to be more prolonged and more serious in patients beyond the age of 50, it was not found to be a more frequent complication of ulcer as age advanced. We found no greater incidence of hemorrhage from ulcer in any given age period. The largest number of patients treated for ulcer and its complications were from 40 to 50 years of age. Among these individuals, however, the mortality rate was not high.

Postmortem examination was made upon all the patients who died from hemorrhage. It was found at autopsy that 6 of the 11 patients had a duodenal ulcer and in 5 there was a gastric ulcer. Of the 6 duodenal ulcers, 5 were found to be on the posterior wall and 1 on the anterior wall. Two of the 5 gastric ulcers were located on the posterior wall. Of the 3 others, one was situated on the lesser curvature, one on the anterior wall near the lesser curvature and in the other there were multiple ulcers in the stomach and in the esophagus. Many of these ulcers were adherent to posterior structures, particularly the pancreas, and would have offered technical difficulties in removal. In one half of the cases of single chronic ulcer the pathologist was able to identify the bleeding point and in each case it proved to be an eroded arteriole. In no instance was erosion of the pancreaticoduodenal artery or other major vessel responsible for the bleeding. The incidence of cardiovascular disease was high in the patients who died. Coronary sclerosis and varying degrees of myocardial failure were present in 5 of these 11 patients.

An appraisal of the status of mortality from ulcer hemorrhage in the group of patients comprising our series has given us useful information which might prove most helpful to the surgeon considering the feasibility of a program of operative intervention for the treat-

ment of massive bleeding from ulcer. In the first place the record obtained in hemorrhage treatment by conservative medical management offers tremendous competition for surgery and has set a rather high standard. A total mortality rate of 8.8 per cent charged to conservative management is a formidable figure for surgeons to improve if they are to assume responsibility for all deaths from hemorrhage. Secondly we feel that it is doubtful that the patient with severe hemorrhage from ulcer which will prove fatal can be reliably separated and singled out for operative interference. On the other hand, several important helpful statements can be made based upon the fact that the age of the patient is the most important factor affecting the outcome of a bleeding episode. It is probably safe to say that surgery has little or no place in the treatment of hemorrhage in the younger patient. Patients under 50 years of age have an excellent prognosis for recovery from a given hemorrhage under medical management. In our series the mortality was under 1 per cent. The younger individual may repeatedly appear to be near death and recover during a serious prolonged episode of bleeding. Surgery done in desperation under these circumstances is probably not advisable and we believe that the patient's chances for survival are better with expectant treatment. Operative interference in this group might result in raising the mortality rate rather than lowering it. In the patient beyond the age of 50 the situation is different. In this group there was a 20 per cent mortality rate which offers an opportunity for improvement. It is possible that surgery has its place in the treatment of hemorrhage in the patient of advanced years. To what extent it should be used and upon which patients in this group operation should be performed, we could not determine from this study. We do know that many of these elderly patients are in poor physical condition when admitted to the hospital and that a certain number cannot be operated upon. If the surgical procedures necessary for arresting hemorrhage were simple and easily performed in a short period of time there might be less hesitancy to recommend surgery on a large scale in this group. An adequate operation for controlling bleed-

ing from an ulcer, however, usually demands that the ulcer be resected. The experiences of many surgeons have shown that ligation of the blood supply to any portion of the stomach or duodenum is an unreliable and usually a futile procedure. Likewise, gastro-enterostomy and jejunostomy are inadequate for the most part and cannot be expected to stop bleeding. Resection of the ulcer may demand considerable time consuming operative work and necessitates in many instances further operation for restoring gastro-intestinal continuity. Most frequently the surgeon will find a duodenal ulcer on the posterior wall, the removal of which will require partial gastric resection. Operations which are questionably adequate for stopping bleeding can only do harm to the patient since they submit him to a risk of his life without giving the security that hemorrhage is controlled.

Reports of large series of cases in which patients were operated upon for hemorrhage cannot be accepted enthusiastically unless they show a reduction in mortality for the age groups from which the patients are taken. Inclusion of a large number of younger individuals in a group subjected to operation will lower operative mortality rates without necessarily improving the mortality rate in general. We believe that estimations of surgical results in reducing mortality from ulcer hemorrhage will be valid when they are made with reference to the accomplishments attained in reducing mortality among the patients in the

various age groups. Before embarking upon a program for surgical intervention in the treatment of massive hemorrhage in patients with gastroduodenal ulcer, the surgeon must accept the fact that the field for improvement in mortality is among those patients beyond 50 years of age. The situation at hand is one which calls for the use of operative procedures of considerable magnitude to be performed upon patients in the sixth, seventh, and eighth decades of life, who are frequently poor risks for surgery.

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THE SIGNIFICANCE OF NUTRITION AND GASTRIC ACIDITY IN THE ETIOLOGY OF EXPERIMENTAL PEPTIC ULCER

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IN 1923 Mann and Williamson described a method for the experimental production of peptic ulcer in dogs. This procedure is essentially an operation which changes the position of the duodenum so that its contents drain into the distal ileum instead of the beginning of the jejunum. The operation (Fig. 1) is performed first by section through the pyloric ring and blind closure of the proximal end of the duodenum. Then the terminal part of the duodenum is cut across at the ligament of Treitz and anastomosed to the ileum at a point 40 centimeters proximal to the cecum. Finally the pyloric end of the stomach is anastomosed to the beginning of the jejunum, where the latter has been severed from the duodenum. Practically every animal surviving such an operation will die of a jejunal ulcer within 90 days.

Mann-Williamson preparations manifest a declining state of nutrition from the day of the operation until death supervenes. This condition is evident by the occurrence of weight loss, anorexia, weakness, and anemia. The rôle of gastric acidity as the etiological factor responsible for ulcerations of the susceptible jejunal mucosa, has been the focus of much attention whereas the relationship of these lesions to the poor nutritional state has been quite overlooked. Neither has any significant investigation been made into the actual effect of the Mann-Williamson operation upon gastric acidity. The little data available through the work of Weiss and Hubster, Morton, and McCann reveals no appreciable change.

The object of this study was to determine the effect of the Mann-Williamson type of operation upon gastric acidity and to evaluate the respective parts played by postoperative

gastric acidity and nutrition in the etiology of the ulcers following such operations.

METHODS

1. In order to study the relationship of gastric acidity and nutrition to the occurrence of jejunal ulcer in Mann-Williamson preparations it was found necessary to devise modifications of the original operation. It was decided to submit the dogs first to a first stage operation (see b Fig. 1) which varies from the Mann-Williamson procedure in that the distal end of the duodenum is anastomosed to the small intestine at a point 120 centimeters distal to the gastrojejunal anastomosis instead of 40 centimeters proximal to the cecum. This change increases the distance between the cecum and the influx of duodenal juices and thus provides a more adequate nutritive state than the original Mann-Williamson operation because much more of the small bowel is exposed to the important digestive action of the biliary and pancreatic juices coming by way of the duodenum. The region of the gastrojejunal anastomosis is anatomically and physiologically the same as in the Mann-Williamson procedure and so an excellent preparation is available to study the gastric acidity factor.

Twenty-eight healthy dogs of mongrel breed and varying weights were placed on a stock diet and permitted to become acclimated to laboratory conditions for 2 weeks. Following this period, fractional gastric analyses were performed on each dog at weekly intervals until 10 determinations had been made. One hundred twenty cubic centimeters of 7 per cent alcohol was used for the test meal. The alcohol was introduced by stomach tube and samples were aspirated every half hour for 2 hours. Fractional gastric analyses were also made to obtain the response to 1 milligram of histamine injected subcutaneously. The con-

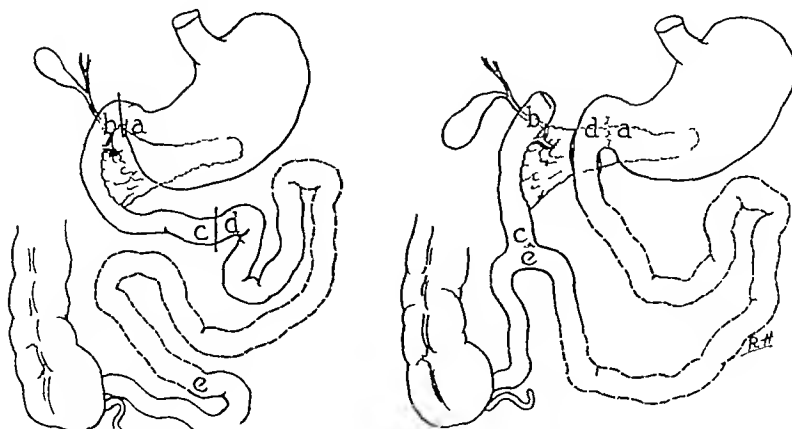


Fig 1 The Mann Williamson operation Note that the distance from the ileocecal junction to *e* equals 40 centimeters

trol values having thus been established, the dogs were subjected to the first stage operation

2 The animals surviving this operation were studied for gastric secretion with alcohol test meals and histamine for 13 weeks, or until death intervened. In those animals still alive, jejunal ulcer was ruled out by making an incision into the pyloric antrum, inserting a small proctoscope and directly inspecting the jejunal mucosa. Then the second stage operation was performed. In this procedure, a segment of intestine between the duodeno-ileostomy and the cecum was resected so that only 40 centimeters of ileum was left between these two points (see *c*, Fig 2). The segment was converted into a Thiry loop, that is, the proximal end was closed blind and the distal end

brought out through a stab-wound in the abdominal wall. In this preparation, the gastric acidity factor has not been altered, but decreasing the length of intestine between the duodeno-ileostomy and the cecum to 40 centimeters (same as in true Mann-Williamson operation) has reduced the nutritional factor by decreasing the amount of intestine exposed to the action of the biliary and pancreatic juices.

3 The animals which did not die of ulcer following the second stage operation were subjected to the third stage operation. This procedure consisted of simply restoring the Thiry loop back into its original position to convert the animal into a first stage preparation. It was hoped this would improve the animal's nutritional condition and save its life.

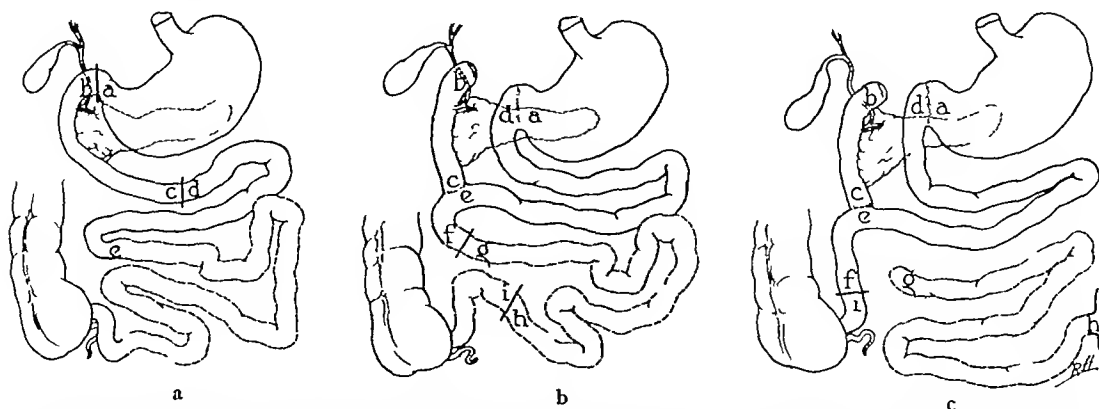


Fig 2 a, Normal b, First stage operation Note that the distance from gastrojejunal anastomosis *ad* to *e* equals

120 centimeters c, Second stage operation Note that the distance from *e* to ileocecal junction equals 40 centimeters

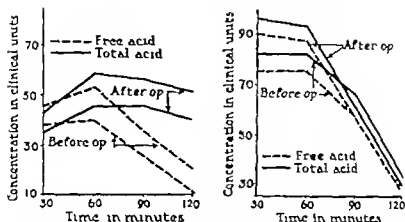


Fig. 3. a, left. Graph of gastric secretory response to alcohol test meal in 24 animals before and after first stage operation. b, Graph of gastric secretory response to injection of milligrams of dextrose in 24 animals before and after first stage operation.

TABLE I—OBSERVATIONS ON THE 24 DOGS SURVIVING FIRST STAGE OPERATION

Dog no.	Weight lbs.	Time observed days	Final weight lbs.	Weight gain per cent	Weight loss per cent	Gastric secretory response	Uterus	Remarks
26	2766	211	286		2	I	O	
27	2615	223	26			U	O	
28	2454		224		26	I	Yes	Perforated ulcer
29		4			20	I	Yes	Perforated ulcer
30		77	5			D	Yes	Shallow ulcer
31	374	230	24		20	I	Yes	Shallow ulcer
32	42	24	234		29	I	Yes	Perforated ulcer
33	5		2742				Yes	Perforated ulcer
335	2284	231				I	O	
36		218	24			I	O	
37	24	211	34			I	O	
38	206	22	207			I	O	
39	20	22	2234		12	U	Yes	Perforated ulcer
40	22	21			22	U	O	Moderate pyrosis
41	20	24	232		20	I	Yes	Chronic ulcer
42	27		22			I	Yes	Chronic ulcer
43	21	20			22	I	Yes	Shallow ulcer
44		200	20			I	O	
45	28	204				I	Yes	Perforated ulcer
46	21	204				U	O	
47	209	204	21			I	O	
48	20	206				I	Yes	Chronic ulcer

I—Increase D—Decrease U—Unchanged

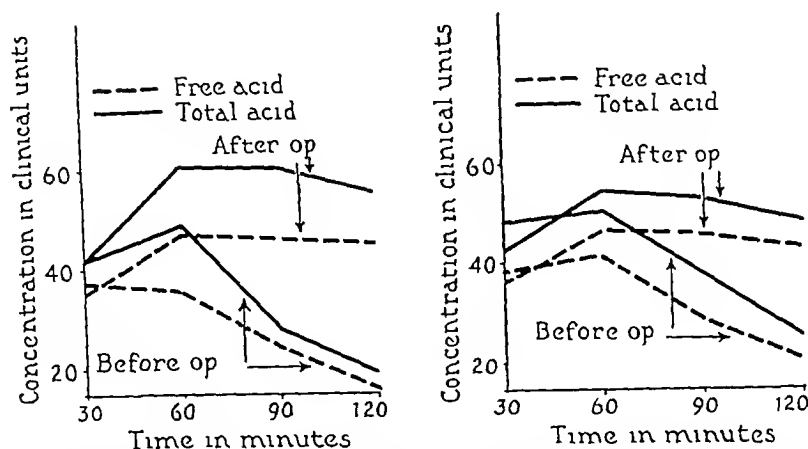


Fig 4 a, left Graph of gastric secretory response to alcohol test meal before and after first stage operation in 12 animals not developing ulcer after operation b, Graph of gastric secretory response to alcohol test meal before and after first stage operation in 12 animals developing ulcer after operation

RESULTS

Twenty-four animals survived the first stage operation. The gastric secretory response to an alcohol test meal before and after the operation was averaged for all these animals, and the results transposed into concentrations in clinical units. A graph was drawn (a, Fig 3) which shows the curves for both free and total acid values before and after the operation. These curves show that after operation there is a marked increase in the acidity of the gastric juice with an alteration in the type of curve. After the operation, there is a tendency to continued secretion at a high level, whereas the control values show a marked drop by the end of the secretory period.

The curves obtained by the gastric secretory response to histamine show a similar change (b, Fig 3). This indicates that the increased acidity of the gastric juice after the first stage operation was not due to alteration in ability of the gastric glands to secrete acid juice.

Table I indicates the weight changes, gastric secretory changes, and the incidence of ulcer formation in the 24 dogs surviving the first stage operation. It is noted that 12 animals developed jejunal ulcer in an average time of 154 days with an average weight loss of 21 per cent. Eleven animals with an average weight gain of 3.2 per cent had no ulcers (proved at second stage operation), and 1 animal died without an ulcer in 151 days.

TABLE II—OBSERVATIONS ON 10 ANIMALS SURVIVING SECOND STAGE OPERATION

Dog no	Weight lbs	Time observed days	Final weight lbs	Weight loss per cent	Ulcer	Remarks
225	20 $\frac{3}{4}$	180	15 $\frac{1}{2}$	25.3	O	Still living
226	36 $\frac{1}{2}$	32	27	24.0	O	Died of intussusception of blind intestinal loop
227	30	104	20	33.3	O	Intussusception
232	24	13	18 $\frac{1}{2}$	21.9	O	Intussusception
235	23	53	18 $\frac{1}{4}$	20.7	Yes	Penetrating jejunal ulcer
236	34	58	21	38.2	Yes	Penetrating jejunal ulcer
237	41 $\frac{3}{4}$	188	27	35.4	O	Still living
239	19 $\frac{1}{2}$	62	14 $\frac{3}{4}$	23.1	Yes	Penetrating jejunal ulcer
248	20	52	12 $\frac{1}{2}$	37.5	Yes	Shallow jejunal ulcer
253	25 $\frac{1}{2}$	56	17	32.7	Yes	Penetrating jejunal ulcer

It is known that almost 100 per cent of true Mann-Williamson preparations will die of ulcer within 90 days. As has been previously explained the first stage animal differs from the Mann-Williamson preparation only in that it has a larger amount of intestinal surface exposed to the action of the biliary and pancreatic juices. It follows, therefore, that in creating the digestive surface decreases the incidence of ulcers and prolongs the time necessary for them to form.

The gastric secretory response to an alcohol test meal in both the dogs developing ulcer after the first stage operation and those which did not were respectively averaged and transposed into units of clinical concentration. Graphs were drawn (a and b Fig. 4) plotting the pre-operative and postoperative acidities (free and total) in both groups of dogs. It is readily seen that almost identical curves are present in the animals which developed ulcers and those which did not. This indicates that there is no relationship between postoperative acidity levels and the incidence of jejunal ulcer.

A study of the individual gastric secretory curves revealed that of 11 dogs developing ulcers subsequent to the first stage operation in which pre-operative and postoperative data are available 7 showed a significant increase in acidity. The gastric acidities of these animals showed a concentration of 50 clinical units or more. This does not indicate a greater tendency toward ulcer formation in dogs with high postoperative acidity because in the 11 dogs which did not develop ulcer a concentration of 50 clinical units or more was reached in 7 instances.

Ten dogs survived the second stage operation. Table II reveals that 5 of these animals developed ulcer in an average time of 56 days with an average weight loss of 20.2 per cent 3 died of intussusception and 2 dogs are still living and apparently will not develop ulcer. It is evident that in dogs with a high internal duodenal drainage jejunal regurgitation could not be the factor that protects the gastrojejunal area from ulceration, because resection of a

large segment of intestine distal to the duodeno-enterostomy results in jejunal ulcers. These lesions, occurring after a procedure which only decreases the total amount of intestinal digestive surface indicate that the rôle of nutritional disturbance is extremely important in the etiology of gastrojejunal ulcer.

Of the 5 animals developing ulcer after the second stage operation, only 2 lived long enough to have a third stage operation. This procedure failed to prolong their lives the animals died shortly after the operation.

CONCLUSIONS

1. When the duodenum of the dog is resected from its gastric and jejunal extremities and a gastrojejunal anastomosis is performed, it is observed that the incidence of jejunal ulcer subsequent to drainage of the duodenum into the small intestine is decreased if the point of drainage is placed closer to the site of the gastrojejunal anastomosis. In other words, the higher the site of internal duodenal drainage the smaller the incidence of ulcers. The time necessary to produce the ulcer is also lengthened.

2. The gastric acidity response to an alcohol test meal and histamine is increased after operations of this duodenal drainage type.

3. There is no relationship between postoperative acidity levels and the incidence of jejunal ulcer.

4. The importance of malnutrition in the development of experimental jejunal ulcer is indicated by the fact that dogs which maintained nutrition and even gained weight after a high duodenal drainage operation, developed ulcers after nutrition was impaired by a resection of considerable small intestine between the point of drainage and the cecum.

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THE RELATION OF CHRONIC CYSTIC MASTITIS TO MALIGNANCY

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THE breast, like the endometrium, is constantly undergoing periodic changes of progression and regression (hyperplasia and involution) from birth to senility. Except for a few periods during life, the histological picture is changed weekly if not daily. It is for this reason that a knowledge of the anatomy and physiology of the organ is essential to a correct understanding of its various pathological processes.

The breasts are covered by the superficial fascia of the anterior thoracic region. From the deeper layers of this fascia, septa proceed inward which divide each mamma into from 15 to 20 lobes which are further divided into many lobules by a continuation of the connective tissue from the parent lobar septa. The parenchyma of the gland is composed of two main structures, specialized connective tissue on the one hand and duct and acinous epithelium on the other. The acini are cluster-like dilatations from the walls of the lactiferous ducts. These ducts are lined with low cuboidal epithelium and are surrounded by a layer of smooth muscle cells supported by the *membrana propria*. The terminal lactiferous ducts are composed of simple cuboidal epithelium supported by a delicate stratum of muscle. It is by junction of these small ducts from the many lobules that the excretory duct of the lobe is formed. Here the epithelial cells have become taller (columnar) and surrounded by smooth muscle, subepithelial connective tissue (6), elastica, the second layer of smooth muscle and the pericanalicular connective tissue. Each excretory duct enlarges near its termination to form an ampulla. Just beyond

the ampulla the epithelium changes from columnar into transitional epithelium which is continuous with the stratified squamous epithelium which covers the nipple.

It is evident that the breast, like the uterus, is under the direct control of the ovary, and the ovary in turn is under the control of the anterior pituitary. The ovary exerts a dual hormonal influence on the breast, the periacinous and periductal connective tissue being governed by the follicular and interstitial parts of the ovary while the duct and acinous epithelium are under the control of the corpus luteum. If this control becomes abnormal by a disturbance in the time or volume of hormonal liberation, the periodic mammary changes may cross the borderline from the physiological into a pathological state (6).

In the newborn relatively few ducts and practically no acini are present (Fig 1). The periductal connective tissue is scant and lymphocytes may be seen in certain areas. As a result of the presence in the blood of the female sex hormone, epithelial proliferation may be marked and may even resemble the activity of lactation. Shortly after birth the breast enters a dormant period due to the disappearance of the female sex hormone.

At puberty, as a result of ovarian activity, the mammary gland takes on new life (Fig 2). Budding takes place, new ducts are formed and new acini develop. At times there is dilatation of the ducts and colostrum and desquamated epithelium may be seen in their lumina. Hyperplasia of the pericanalicular and periacinous connective tissue is present with lymphocytic infiltration into these specialized connective tissue elements.

With the establishment of menstruation the breast undergoes cyclic changes as a result of ovarian stimulation.

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Fig. 1. Breast of newborn. In this section is seen group of ducts which are surrounded by scant connective tissue.



Fig. 2. Breast at puberty. There is marked dilatation of the duct. Its colostrum is the darker. Hyperplasia of the periductular connective tissue is evident.



Fig. 3. Postmenstrual breast. The entire picture is one of inactivity: the ducts are small, the epithelium low and dry connective tissue bands are prominent.



Fig. 4. Premenstrual breast. There is budding and new duct formation. The epithelium is active and round cells are present.



Fig. 5. Breast during pregnancy. X40

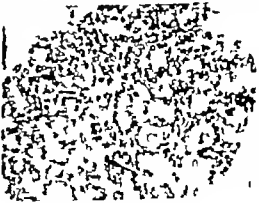


Fig. 6. Breast during pregnancy. X160



Fig 7 Lactation Fat and connective tissue have been replaced by ducts and acini. The epithelial cells show different degrees of secretory activity.

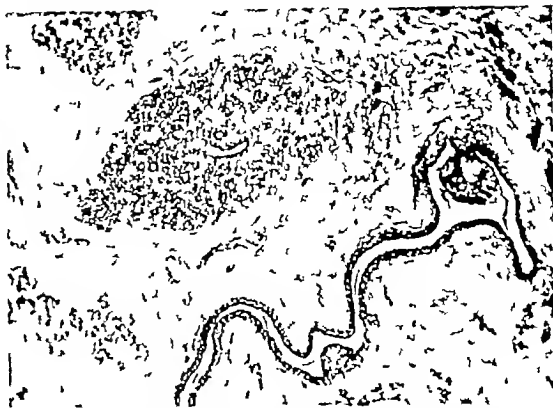


Fig 8 Involution In this section there is found general atrophy and disappearance of the new ducts and of the acini.



Fig 9 Periductal fibroadenoma Small groups of ducts surrounded by much pericanalicular connective tissue.



Fig 10 Intracanalicular fibroadenoma The proliferating connective tissue has invaginated the duct.



Fig 11 Adenosis Dilated ducts, epithelial hyperplasia and papillomas.

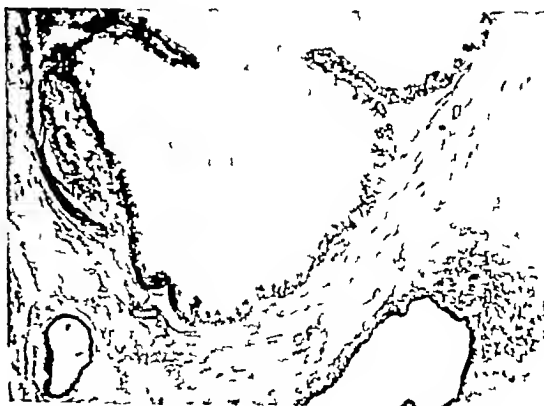


Fig 12 This section shows cyst containing intraductal papilloma.

Fig. 3 Papilloma. $\times 60$ 

Fig. 4 Adherent papilloma



Fig. 5 Benign comedo adenoma

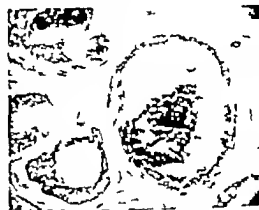
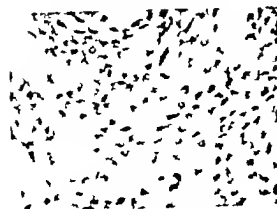


Fig. 6 Intraduct carcinoma.

Fig. 7 Intraduct carcinoma $\times 60$.

In the usual virginal breast for 10 days immediately following menstruation one observes a regressive stage in mammary activity (Fig. 3). The epithelium of the ducts is quiescent and inactive and the acini are rudimentary or absent. The periacinous and periductal connective tissue is active and sharply demarcates the lobules from the surrounding supportive tissue. Lymphocytes may be seen scattered throughout the specialized connective tissue.

After ovulation on the fourteenth or fifteenth day of the menstrual cycle the corpus luteum forms and the breast enters the proliferative stage (Fig. 4). The specialized connective tissue softens and becomes myxomatous to

allow for gland expansion" (5) The epithelium is active and piles up in the dilated lumina of the ducts. Vacuoles develop in the cytoplasm and the ducts show marked budding. Round cells continue to invade the connective tissue. Secretion appears in many ducts and this completes the picture often seen in the swollen, tender breasts commonly preceding menstruation. The activity of the glandular epithelium and connective tissue is always in preparation for pregnancy just as the secretory phase of the endometrium is a preparation for nidation of the ovum. If the ovum is fertilized and gestation progresses, the cuboidal epithelium lining the acini undergoes a process of fatty degeneration to form first colostrum and then milk. If the ovum is not fertilized, the breast returns to the resting condition by a process of degeneration similar to that of the endometrium. The duct and acinous epithelium degenerates, is shed into the lumen, and the cell debris is eliminated by the action of mononuclear phagocytes.

During pregnancy the breast undergoes its greatest physiological change (Figs 5 and 6). Under the influence of the corpus luteum of pregnancy the epithelium grows at the expense of the connective tissue. Many new acini are formed from the budding ducts and the fat is replaced by the abundant epithelial tissue. Immediate secretory activity is probably delayed by the antagonistic action of the placenta.

When the fetus is delivered and the placenta discharged, the inhibitory agent is no longer present and the proliferative stage gives way to the secretory or the *stage of lactation* (Fig 7). Microscopically the lactating breast is uniform in appearance, the fat and specialized connective tissue are replaced by enormous growth of ducts and acini. The lobules are enlarged, the epithelium is hypertrophied, and the glands show different degrees of secretory activity.

When lactation ceases, the breast enters into a state of *involution* (Fig 8). There is general atrophy and disappearance of the new ducts and acini, but here and there both ducts and acini may remain. The returning connecting tissue undergoes hypertrophy and the breast never completely returns to its former

state. Certain parts will show epithelial and connective tissue atrophy resembling that seen in the regressive stage in the virgin, while in other areas there is hypertrophy of the specialized connective tissue with round cell infiltration and desquamation of epithelium into the terminal ducts. This is the *mazoplasia* of Cheatele and Cutler and should not be confused with chronic mastitis for "the function of the mononuclear cells is to remove the products of secretory activity and clean up the cell debris" (5). This is merely normal phagocytic activity and should not be confused with infection.

Not infrequently the terminal ducts remain distended with accumulation of dead epithelial cells therein and the case is erroneously labeled chronic cystic mastitis. This also is a part of the *mazoplasia* of Cheatele and Cutler and should not be confused with a true pathological process. "Mazoplasia is present in nearly all women between 30 years of age and the menopause and disappears with the advent of the latter. It is characterized by diffuse pain over one or both breasts, which is aggravated by menstruation and movement of the upper extremities. There is a fine nodularity present in non-fatty breasts, and menstruation is short and scanty. The condition occasionally disappears spontaneously or during pregnancy."

As previously stated, the breast is continuously undergoing changes of progression and regression as a result of hormone stimulation. Since the endocrine life of the individual is different during the various decades, it is logical to assume that pathological change will bear a close relationship to the various decades of life. Such is the case.

During the first decade of menstrual life two common pathological changes occur in the breast. These are periductal and intracanalicular fibroadenomas (Figs 9 and 10) and are probably the result of over hormone stimulation or endocrine hypersensitivity on the part of certain tissues. In the former, small groups of ducts possessing inactive epithelium and surrounded by a large amount of pericanalicular connective tissue are seen. In the latter, the ducts have been invaginated by the proliferating connective tissue.

During the second decade of menstrual life the border line between the physiological and pathological is frequently crossed and chronic cystic mastitis develops. The term chronic cystic mastitis covers a wide range of altered physiological and pathological processes. Its use is misleading and a clear understanding of the processes involved has been made difficult by the multitude of names by which it has been called. It includes the Swiss cheese type of cystic disease described by Reclus in 1883 and designated by his name. It also includes a non-encapsulated papillary cystadenomatous condition of the breast described 23 years later by Schimmelbusch and called Schimmelbusch disease. To these may be added the fibroadenomatous cysts of Semm and the Cobblestone breast of Warren. The condition is also frequently designated as shotty breast or simply as benign cystic disease. Bloodgood made extensive studies and labeled the condition senile parenchymatous hypertrophy and insisted that the condition was not precancerous. Cheate and Cutler have contributed the title cystipherous desquamative epithelial hyperplasia and Lewis and Geschickter (12) have recently divided the condition into adenomas and cystic disease. Boyd's name of cystic hyperplasia is a practical one.

The various changes that take place are probably the result of ovarian stimulation but Adair and others believe them to be the result of inadequate duct drainage and stagnation resulting in irritation and stimulation. The changes may take place locally in one system of ducts or lobe of the breast and be recognized by its triangular shape with apex near the nipple and base toward the periphery. One hemisphere the entire breast or both breasts may be involved. In contrast to the first decade of menstrual life, it is the epithelium which is involved here instead of the connective tissue. This altered physiology results in the production of chronic cystic mastitis and the blue dome cyst of Bloodgood.

If adenomas (the cystipherous desquamative epithelial hyperplasia with neoplasia of Cheate and Cutler) is the predominating feature (Fig. 11) microscopic examination of the area reveals epithelial proliferation with the formation of small intracystic papillomas

or non-encapsulated adenomatous areas. The cystic disease may be characterized by the formation of one or several well developed cysts, the so called bloodome cyst of Bloodgood. The lining epithelium is flattened from intracystic pressure, and Bloodgood contended that these lesions had no relationship to malignancy. However if one sections the entire gland, dilated ducts containing intraductal papillomas are frequently observed and these not infrequently show the presence of malignant change (Fig. 12).

In the third decade of menstrual life certain breasts fail to cease activity with cystic hyperplasia and go on to benign neoplasia, and possibly carcinoma. The active epithelium is laid down layer by layer to form sessile papillomas. In other instances connective tissue stalks invade the epithelial growths and true papillomas are formed (Fig. 13).

At times the multiple papillomas attach themselves one to the other to form new gland surfaces and adenomatous masses (Fig. 14). These are the so called comedo adenomas of Bloodgood (Fig. 15). When sectioned at the operating table, pinhead or pinpoint sized ducts are seen, which upon pressure send forth worm-like masses of yellow (comedones) caseous material. Bloodgood insisted that these adenomas were all benign. We are unable wholly to support this view. Our series of cases have proved to our satisfaction the existence of both benign intraduct adenomas and various degrees of malignancy in duct carcinomas (Figs. 16 and 17).

In cases that were microscopically malignant our records show both success and failure following the same technique of complete operation and deep roentgen therapy. Cutler has shown cyst papilloma and carcinoma in the same duct and sets forth evidence that 20 per cent of all carcinomas of the breast have their origin in cystipherous desquamative epithelial hyperplasia.

The evidence at hand seems to favor the idea that the greater number of pathological changes in the breast are hormonal in origin. As previously stated experimental investigation has established the dependency of mammary connective tissue development upon the follicular hormone and of epithelial tissue ac-

tivity upon the corpus luteum. If one accepts this relationship between ovarian secretion and mammary activity, it is easy to visualize a disturbance in this delicate balance with resulting disturbances in hyperplasia and involution. In many cases the fault may lie in the anterior pituitary since this gland is the dynamic motor activator of the ovary.

To a group of patients complaining of pain, tenderness, induration or nodularity of the breast, we are administering the estrogenic hormone (progynon) with promising results. Hormonal therapy is directed toward counterbalancing the effect of the corpus luteum in order to bring about involution in the glands. Ten thousand international units are given the first week in the menstrual cycle. The same dose is repeated the second week and twenty thousand units are given the third week. This course of treatment is followed by the administration of ten thousand units each third week thereafter.

The patient rarely calls attention to induration and fine nodularity of the breast, but is greatly concerned, and properly so, when a solitary mass appears. When the latter occurs, hormone treatment should never be instituted and expectant treatment has no place in the management. In our clinic each patient is prepared as for radical operation and the tumor removed, the excision being done in such a manner as to include a wide margin of normal breast tissue. The operator bisects the tumor for macroscopic inspection and turns it over to the pathologist, who is always present at the operation. Immediate frozen sections are made and if upon microscopic examination the lesion is found to be benign, the wound is closed, the operator changing gloves and instruments in every case after bisecting the tumor. If the microscopic examination reveals a malignant tumor, the radical operation is done at once and adequate deep roentgen therapy is given. A register is kept of all cases and the gross specimen and microscopic slides are preserved along with the case history for future reference.

A close association between surgeon and pathologist is a great help in the diagnosis and management of mammary disease. We believe that the adoption of this or a similar plan

in the management of all breast cases will aid in the accuracy of diagnosis and the elimination of unnecessary operations. Furthermore, a step toward the prevention of carcinoma will be taken by the early and wide removal of pathological lesions. Life may be saved by thorough study of the pathological change in each patient at time of local removal, to be followed immediately by complete operation when pathologist and operator agree upon malignancy.

CONCLUSIONS

The problem of interpreting the pathology and the management of so called chronic cystic mastitis is yet unsolved. The multitude of names applied are confusing and an effort has been made to clarify this. Many authors using the common name feel that it is unsatisfactory, including as it does borderline condition between the physiological and pathological, as well as benign tumor masses and malignant hyperplasia.

The persistently high mortality rate in treatment of cancer of the breast, 50 to 65 per cent, in spite of the standardized operative and irradiation techniques, calls for intensive study and prophylactic steps. The treatment of certain early stages or forerunners of chronic cystic mastitis with hormones, is a step in the proper direction and may lead us into a beneficial prophylactic field.

We feel that it is the duty of the obstetrician to instruct patients about the care of the breast as well as of the uterus. We also feel that the gynecologist and surgeon should join hands with the pathologist in the operating room and laboratory, in order to reach a more accurate diagnosis and through it institute the most efficient and satisfactory treatment.

We desire to express our appreciation to Dr. Charles F. Geschickter for the privilege of studying in the surgical pathological laboratory of Johns Hopkins Hospital and for suggestions and loan of material.

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CLINICAL SURGERY

FROM ST VINCENT'S AND THE ROYAL NORTH SHORE HOSPITALS, SYDNEY

OPERATIONS FOR GALL STONES

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ALTHOUGH the surgical treatment of gall stones has been established for many years, there is still considerable divergence of opinion concerning many technical details and the indications for operation in acute cases. The extent of the operation is largely determined by the character and site of the gall stones and the pathological conditions found when the abdomen has been opened.

PREPARATION OF PATIENT

A thorough investigation of the patient is made and the usual general and local preparation for operation carried out. No aperients are given less than 36 hours before operation. An enema is usually given the night before and not less than 4 to 6 hours before operation. Intramuscular injections of colloidal calcium (0.5 cubic centimeter) should be given on the eve and on the morning of the operation to jaundiced patients or others who may have a tendency to hemorrhage. If the Quick test shows that prothrombin is decreased, vitamin K and bile salts should be given.

ANESTHESIA

A well administered anesthetic is of primary importance and should provide freedom from oozing and good relaxation. While general, local, or spinal anesthesia may be used, one of the general anesthetics is preferred, of these, ether appears to be the best and to give greater relaxation and less tendency to bleeding than the other inhalation anesthetics. Atropine should be given as a routine before operation. The skill and experience of the anesthetist are probably of greater importance than the anesthetizing agent. Bad anesthesia may make a simple procedure extremely difficult and the more postoperative vomiting that occurs the greater the liability to an incisional hernia.

CHOLECYSTECTOMY

Indications The gall bladder should be removed whenever possible if gall stones are present,

also after choledochotomy when it is certain that the common bile duct is clear. Removal is contra-indicated in those acute and subsiding cases in which there is a thick, brawny infiltration with shortening of the mesentery of the cystic duct, and in most cases in which, during operation, satisfactory exposure of the region of the cystic duct cannot be obtained.

Incision The upper right rectus paramedian incision is employed almost invariably and is preferred to the Kocher and other incisions. Before the incision is made 3 or 4 superficial scratches are made in the skin with the point of the knife drawn backward horizontally across the proposed line of incision at the levels in which it is intended later to insert the deep skin sutures (Fig. 1). The incision itself should be from 4 to 6 inches in length. As soon as the rectus sheath is exposed, the drawing of the end of the handle of the scalpel along it in the line of the incision bares the anterior wall of the sheath sufficiently to facilitate the incision into it.

The rectus sheath should be opened vertically in its inner third, preferably about $\frac{3}{8}$ to $\frac{1}{4}$ inch to the right of the medial border of the rectus, a little more than sufficient of the sheath being left to hold the suture. In this way most of the rectus muscle is left undisturbed in its attachments and its relations to the anterior wall of the rectus sheath, and less bleeding is encountered from vessels in the muscle. The muscle is carefully dissected from the anterior sheath of the rectus medial to the incision, where it is firmly attached along the lineæ transversæ, and retracted to the right. The peritoneum is opened about $\frac{1}{2}$ inch lateral to the incision in the sheath, so that the line of suture of the wall lies immediately behind the midline of the rectus muscle and lateral to the incision in the anterior sheath. Side towels are placed in and a moist pack is placed in the abdomen. A four-bladed, self-retaining abdominal retractor gives better exposure through a shorter incision and an immobile field.

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when the operation is performed from the fundus down, the common duct is much more liable to injury than when the operation is begun at the cystic duct

Removal of the contents of the gall bladder frequently makes the operation considerably easier, and should be done in all cases in which access to the region of the cystic duct is difficult or is obscured by a dilated gall bladder, and particularly when a large stone is impacted in Hartmann's pouch. A purse-string suture, about 1 inch in diameter, is placed around or near the apex of the gall bladder and the area is held taut with forceps. The gall-bladder area is thoroughly packed off with sponges and a special trocar and cannula attached to a suction apparatus are plunged into the center of the purse-string suture and the fluid contents of the gall bladder are removed. As the cannula is withdrawn, the purse-string suture is tied. If large stones are present, before removal of the cannula, it may be necessary to enlarge the opening sufficiently for a scoop to be inserted to remove them. The purse-string is tied tightly and the end is left long to be used for retraction.

A curved clamp is now placed on the fundus of the gall bladder (Fig 2). In the placing of clamps, which should be long-handled, curved, and blunt-pointed, their tips should be beyond gall-bladder tissues if possible, and they should not be placed on the gall bladder until it has been determined that the common duct is clear and that cholecystectomy is to be performed. Three pads are then placed in position, one in the right subhepatic pouch, one in the left to keep the stomach to the left, and one over the transverse colon. This last mentioned pad is covered by the left hand of the first assistant, who draws the tissues down from the lower surface of the liver in such a way that the right edge of the lesser omentum is taut and free.

A second curved forceps is then placed on Hartmann's pouch and this forceps held by the second assistant (Fig 2). When retracted, this straightens the cystic duct and makes the lower border of its mesentery taut. This border is then incised just below the neck of the gall bladder by a pair of scissors (Fig 2, A) and, by dissection with gauze on sponge forceps (Fig 2, B), the peritoneum and fatty tissue are stripped until the common bile duct is exposed medially and the cystic duct above. As soon as the cystic duct is exposed, it is usually necessary to remove the forceps from Hartmann's pouch and to place it at a lower level, so that when retracted the cystic duct is still taut. At this stage the common duct

is liable to injury, as in some cases it may be drawn upward and may either be inadvertently surrounded by a ligature or tied in a V-shaped manner at its junction with the cystic duct. This may happen not only in difficult cases but also in those in which the gall bladder can be brought up with unusual ease. The common duct can be recognized from its situation, its appearance, color, width, and thickness, and by the arrangement of the veins upon its walls. When the cystic duct comes into view a special curved dissector is passed close to and immediately above the duct (Fig 3), it is then withdrawn and a pair of long-handled curved forceps is passed through the opening. The blades are then slightly and gently opened (Fig 3, A). This strips the mesentery from the cystic duct which is now free and which should be seen in its length. Care must be taken when small stones are present in the gall bladder and the cystic duct is dilated, to see that no stones or debris are allowed to enter the common duct from the cystic duct during the performance of these manipulations.

At this stage it is necessary to review the decision to open the common duct. In some cases the stones in the gall bladder may be so large and in others the lumen of the cystic duct so small that it is obvious that no stones could have passed from the gall bladder into the common duct. The common duct is again inspected and palpated, and the final decision whether it should be opened is made. Most careful examination may be required, and if there is still any doubt at this stage the duct should be explored.

Having decided to proceed with cholecystectomy, the surgeon places a clamp on the cystic duct, close to the common duct, and another at its junction with the gall bladder (Fig 3, B). The lower one must be as close as possible to the common duct and its tips must be free. It is then removed and the crushed area is securely tied with catgut (Fig 3, C), many surgeons prefer silk for this ligature. If necessary, a second tie is made. The duct is then cut at least $\frac{3}{8}$ to $\frac{1}{4}$ of an inch distal to the ligature (Fig 4, A). The ligature is left long and is secured by artery forceps, but must not be retracted by the assistant for fear of its being displaced.

The cystic vessels are then secured in their mesentery. Clamps should be avoided during this procedure. Isolation of the vessels is unnecessary and may be dangerous. The liver lies above the mesentery, the common hepatic duct to its left and behind it, the gall bladder above, and the divided cystic duct below. The width of the mesentery is from $\frac{1}{4}$ to $\frac{1}{2}$ inch and it may be

General examination of the abdomen. The hand is now passed carefully into the wound beneath the liver and a preliminary examination of the region of the gall bladder is made. Except in the presence of acute disease of the gall bladder dense abdominal adhesions, or other contra-indications, all abdominal viscera are then systematically and rapidly examined in order to detect any abnormal condition.

The next step in the operation is the examination of the liver, gall bladder and bile ducts. A moist pack is placed above the colon and the left hand of the first assistant retracts the intestines from the under surface of the liver (Fig. 2). When properly retracted, the right free edge of the lesser omentum should be taut and about half an inch in front of the posterior abdominal wall.

The gall bladder is examined and palpated for gall stones and its pathological condition is noted. The presence of adhesions is determined and particular attention is paid to the pathological condition of the tissues in the region of the cystic duct.

When adhesions are present, they can in the majority of cases be stripped very readily from the gall bladder as far as the common duct by a gauze swab on a sponge holding forceps. Adhesions which are the accompaniment of an acute inflammation of the gall bladder can often be stripped easily. Thicker adhesions are usually the result of previous attacks and adhesions following a previous cholecystostomy are usually very thick and extensive while thick adhesions to the colon, stomach, or duodenum may be associated with a fistula between the gall bladder and these organs. At times a distended Hartmann's pouch of the gall bladder may be found adherent to the common duct but can usually be separated with ease. Adhesions to the liver at one or both sides of the gall bladder are not uncommon. If they are at all firm or do not strip readily they must be carefully tied and divided. Failure to take this precaution may result in the stripping of a portion of the capsule of the liver and cause troublesome bleeding.

When the gall bladder and right free edge of the lesser omentum have been displayed, the assistant removes his left hand and a careful examination of the cystic duct, the common bile duct, the head of the pancreas, and the second part of the duodenum is made. They are first inspected and then palpated. To do this, the surgeon should place his right thumb in the opening of the foramen of Winslow (*for men pyloricum*) and palpate the common duct between the fingers and thumb throughout its whole

length to determine whether it contains any calculi. If the surgeon is standing on a stool it is easier for him to place the right index finger in the foramen and to carry out palpation between the forefinger and thumb with the hand pronated. Hard glands beneath the pylorus or in the region of the head of the pancreas may cause some uncertainty. The decision whether the common bile duct is to be opened should be made at this stage of the operation if possible. Particular attention should also be paid to palpation of the gall bladder to determine the type of stone present. If it is decided to open the duct it should be done at this stage.

It is also at this stage that the decision is made whether cholecystectomy shall be proceeded with or cholecystostomy performed. The decision is mainly dependent on the pathological conditions which have been displayed and the exposure obtained in the region of the cystic duct. Thickening and edema of the wall of the gall bladder especially if recently acute and associated with a similar condition of the mesentery of the cystic duct, favor the choice of cholecystostomy as the operative procedure.

Having made the decision to remove the gall bladder either without or after opening the common bile duct, the surgeon should consider whether exposure is adequate whether he should remove the gall bladder beginning at the fundus or at the cystic duct, and whether he should first open the gall bladder and remove its contents. If exposure is inadequate various steps may be required. It may be necessary to increase the depth of anesthesia, to enlarge the incision to raise or lower the bar of the table to alter the position of the patient on the table or to try a different position. Other methods used by surgeons are to divide the ligamentum teres between ligatures and thus to allow the liver to be tilted forward, to place a pack above the liver or even to bring about collapse of a distended stomach by inserting into it a cannula attached to a suction apparatus.

The gall bladder should, whenever possible be removed from below upward. In some instances when the cystic duct and its mesentery have been tied and divided, however it may be more convenient to do the actual removal of the gall bladder itself from the fundus down. In those cases, however in which owing to the pathological state of the gall bladder and particularly of the tissues in the region of the cystic duct, removal from the fundus downward may appear to be the method of choice simple cholecystostomy is often preferable. In cholecystectomy

when the operation is performed from the fundus down, the common duct is much more liable to injury than when the operation is begun at the cystic duct

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wider its length is from 1 to 2 inches. The cystic artery arising from the right hepatic artery runs up in the substance of the mesentery reaching it usually by passing behind the common hepatic duct. In rare instances a loop of the right hepatic artery may pass into the mesentery; it usually can be easily recognized by its size and direction. A blunt, ligature-carrying dissector should be used, and if this is passed immediately above the stump of the cystic duct as directed and to the right of and some distance from, the common duct (Figs. 4, B and 4, C) there is little or no danger of injury to the right hepatic artery or common duct. The mesentery is divided close to the gall bladder, the surgeon making certain that at least $\frac{3}{4}$ inch of tissue is left beyond the ligature (Fig. 4, D). If it appears likely that less than this will be left after division of the mesentery another ligature should be passed and tied before it is divided. Ligatures are left long and secured by artery forceps and must not be retracted by the assistants. After the division of the mesentery any bleeding vessel should be secured in a clamp and immediately tied.

The technique described is aimed at avoidance of accidental injury to the common duct, the correct placing of the ligature on the cystic duct, and the avoidance of hemorrhage from the cystic artery. These objectives are obtained by complete visualization of the cystic duct and its junction with the common duct, by division of the cystic duct before the cystic artery is tied, by the avoidance of clamps on the cystic artery by ligature of the cystic mesentery before division, and by division of the cystic duct and cystic mesentery well beyond their ligatures. Attempts to isolate the cystic vessels separately are considered dangerous and, particularly attempts to ligate them before division of the cystic duct.

It remains only for the gall bladder to be removed. There are several methods for its removal, the simplest being employed. The removal is best begun at the right side of the gall bladder, just above the level of the cystic duct. A second pair of curved forceps is applied to the cystic duct, as the one already on the duct sometimes tends to slip off during the subsequent manipulation. The peritoneum is divided on the right lower portion of the gall bladder and, by means of a pair of curved scissors, its lower end is freed. Incisions may now be made in the peritoneum on each side of the gall bladder or it may be removed by scissors dissection from below. A pair of right-angled scissors is useful for this purpose. It is often convenient to stop this dissection when it is half completed and finish the first part of the subsequent

suture (Fig. 5). After the removal of the gall bladder a clamp is placed on the tissues at the upper end of its bed.

At times it may be more convenient, after ligation of the cystic duct and artery to remove the gall bladder from above downward. If the gall bladder has sufficient mesentery one or more clamps may be applied to it and the gall bladder simply cut off. Infiltration of the gall-bladder bed to facilitate its removal has been recommended by Wilkie; this, however is not always simple and there is danger that the gall bladder wall may be perforated with the point of the needle. When the cholecystectomy itself is carried out from above downward, it is usually advisable first to open the gall bladder and to remove its contents. If the dissection between the gall bladder and its bed is carried out in the right layer the gall bladder often strips very easily. When the neck of the gall bladder is reached the cystic mesentery is carefully ligated and divided, the gall bladder being left attached only by the cystic duct. This is carefully crushed, tied, and divided, particular attention being paid to the site of its division in relation to the common duct.

When the gall bladder has been removed it should be taken away and opened immediately by an assistant. It should be split longitudinally and the cystic duct laid open. The specimen is viewed by the surgeon who notes particularly the size of the cystic duct and the number, nature, and size of the stones present. A stone to fit a facet on another stone may be absent, suggesting its presence in the common duct. Injury to the common duct may also be discovered at this examination.

The gall-bladder bed is now carefully examined for bleeding. If the steps of the operation have been correctly followed, the only bleeding at this stage should be from the cut edges of the peritoneum or oozing from the liver bed. The former is dealt with by artery forceps and ligatures, the oozing from the liver bed by pressure, hot packs, and the subsequent suture. When bleeding is under control the suture in the gall-bladder bed is completed. This suture is usually begun when about half the gall bladder has been freed from its bed, the gall bladder being gently used as a retractor (Fig. 5). The first bite of the needle should be passed through the mesentery of the cystic duct close to the ligature already placed there in such a way that the suture is a second insurance against bleeding from the cystic artery. No attempt is made to suture the peritoneum over the cystic duct unless this can be done very simply and without difficulty. Using a long, semi-round needle

and a Gentile needleholder, the surgeon oversees the gall-bladder bed with a continuous mattress suture of plain catgut (Fig 6). The length of the needle is important. Short needles are apt to tear the liver and to cause unnecessary bleeding. The end of the suture is left long and secured by forceps. Hemostasis is again checked and any bleeding is dealt with by tying or by the insertion of hemostatic sutures which, if they pass through the liver, must be very lightly tied. If any oozing is still present, it may sometimes be controlled by the application of dry aristol powder. All blood is mopped out, packs are removed, and a clean pack is placed beneath the liver.

At this stage the appendix is best removed. It can usually be brought into the wound without great difficulty. When it does not come up readily, the base is secured and an untied ligature is passed beneath the appendix at its junction with the cecum and used to retract it. Appendicectomy is then performed in the usual manner.

The gall-bladder area is now re-examined for any signs of bile or bleeding. Bleeding from the liver can as a rule be easily controlled by a mattress suture, lightly tied. If any bile is present, its source must be investigated and the ligature which has been placed on the cystic duct must be carefully examined.

Packs are counted, the self-retaining retractor is dismantled, and the gall-bladder rest is lowered. A small tube is placed beneath the liver and brought out through the upper angle of the wound. This is considered safer and is preferred to a stab wound in the right loin, which is favored by many surgeons. A stab wound, at times, is the cause of troublesome bleeding. The tube is fixed in position by a stitch of silkworm gut through all layers of the abdominal wall, at each end of which artery forceps are placed. The end of the tube should lie so that its lower end is at the level of the cut end of the cystic duct (Fig 6, A).

It should be the rule to insert a drainage tube, particularly if there has been any soiling of the wound by bile or by the contents of the gall bladder, if there is any oozing of blood, or if the common duct or gall bladder have been opened. On no account should a pair of artery forceps be placed on the end of the tube to be removed later in the ward, particularly if the common duct has been opened. The most serious accidents have been reported from omission to remove the forceps after the patient has been returned to bed. In many cases the peritoneal cavity may be closed without drainage if the operation has been easily carried out and when the operative area is quite dry and all raw surfaces are well covered. If,

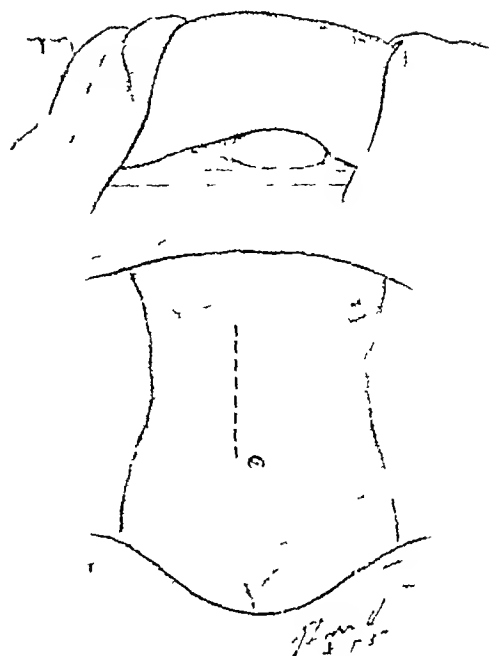


Fig 1. The upper diagram illustrates the position of the patient for operation, with a sandbag or gall bladder rest placed at the level of the lower costal margin. Below is shown the site and length of incision with the transverse scratches made on the skin to facilitate accurate apposition of the skin.

however, there is the slightest oozing, a drain should be used.

Closure of the wound. Before the peritoneum is closed, a careful check is made to see that all packs have been removed, that there is no free bleeding, and that the tip of the drainage tube is correctly placed. The omentum may then be brought up and packed under the tube into the operative area. The wound is then closed with meticulous care. Plain catgut only is used throughout. The position of the deep silkworm gut sutures is determined by the guide scratches made at the time of the skin incision. These sutures include the anterior rectus sheath, the muscle is avoided. The suture holding the tube is cut so that its ends are twice the length of those of the other sutures, and so that it may be readily recognized during after-treatment.

CHOLEDOCHOTOMY

While the decision to open the common duct may have been made before operation in many cases the decision may be delayed until the gall bladder and common duct have been exposed.

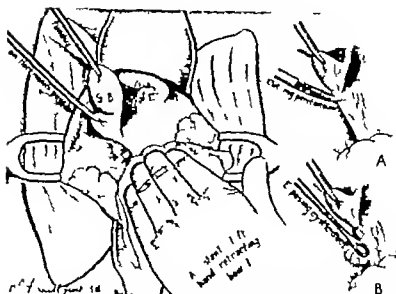


Fig. 2. Exposure of the gall bladder and bile ducts. A four-bladed, self-retaining abdominal retractor is used and pads are placed, one above the transverse colon, one on the right, and one on the left. The field is exposed by the left band of the first assistant. Clamps are shown on the fimbriae of the gall bladder and in Hartmann's (omae). The latter, when retracted, straightens the cystic duct. A, The sh. here the peritoneum is opened, and, B, the stripping of the cystic duct.

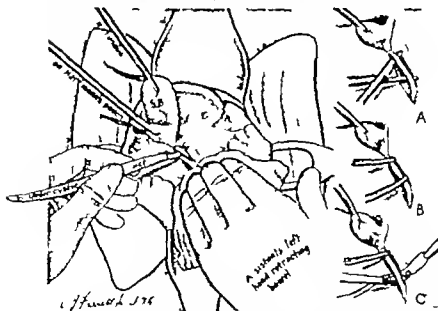


Fig. 3. Isolation of the cystic duct. A curved director is passed immediately above the cystic duct, through the opening thus made is passed a pair of curved forceps, which is gently opened. A, displaying the cystic duct and its junction with the common duct. Clamps are applied to the cystic duct near the gall bladder and as close as possible to the common duct, B. The latter clamp is removed and the crushed area tied prior to division of the duct, C.

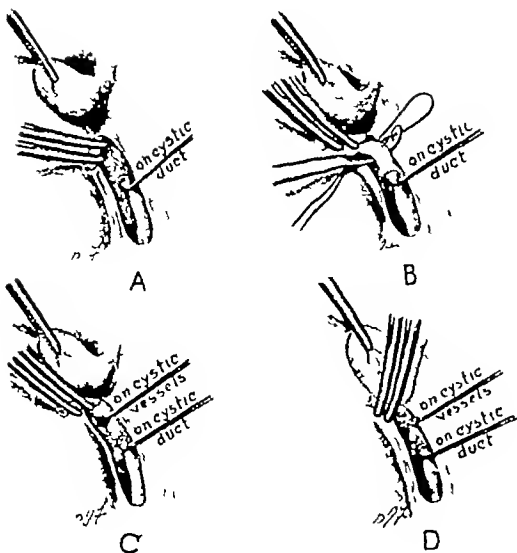


Fig 4 Division of the cystic duct and ligature and division of the cystic mesentery A, Division of the cystic duct and a second pair of forceps placed on the duct. No attempt is made to isolate the cystic vessels which are included in the ligature passed through the cystic mesentery, B and C, which is then cut, sufficient tissue being allowed beyond the ligature to prevent slipping, D

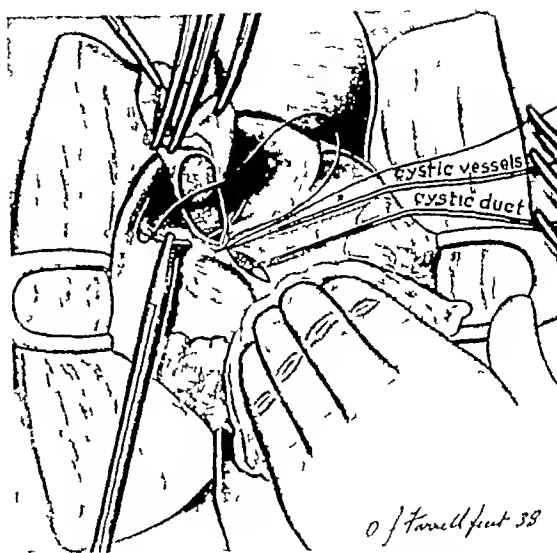


Fig 5 The beginning of the suture of the gall bladder bed before removal of the gall bladder, the first suture being placed in the cystic mesentery to reinforce the ligature

The opening of the common duct increases the danger of the operation and is not necessary in most cases. Some surgeons, however, advise it as almost a routine procedure. Failure to open the common duct when required may have very serious consequences.

The decision is guided by the following considerations. There is no need to open the common duct (1) when there is a single large calculus or when there are a number of calculi out of all proportion to the size of the cystic duct, (2) when there is a very small and attenuated cystic duct. The common duct should be opened (1) when a stone can be felt along the course of the duct, (2) if jaundice was present on admission, even though the jaundice has subsided at operation—a history of jaundice during a former attack is not sufficient indication unless supported by conditions found on examination of the duct itself—(3) if the cystic duct is dilated, (4) if the common duct is dilated, unless there are clear indications against doing so—dilatation of the common duct of moderate degree, however, probably occurs as a secondary phenomenon without the presence of calculi within it in most long standing cases of non-functioning gall bladder, (5) in all cases of doubt, especially if there is thickening of the head

of the pancreas, apparently not malignant, or if a small contracted gall bladder is present.

The operative technique is the same as that already described for cholecystectomy until the exposure of the cystic and common ducts (Fig 2, A). No clamps should be applied to the gall bladder until it has been decided what is to be done with it at the conclusion of the operation on the common duct. Very frequently at this stage it is wise to go on to the isolation of the lower part of the cystic duct. If a ligature is then placed in the opening so made, it acts as an excellent retractor (Fig 7, A). The further procedures are somewhat dependent upon the conditions which are found. One or more stones may be found within the duct or a stone may be felt impacted in Vater's papilla.

The opening in the common duct can usually be made at the site of election, which is just below its junction with the cystic duct. The cystic duct should be clearly visible and held taut during this procedure (Fig 7, A).

Before the duct is opened, some bile is withdrawn with a syringe and needle at the site of the proposed incision (Fig 7, B). Some bile now seeps through the needle hole and on each side of this strong, fine, silk sutures are passed on a small, curved needle. These two silk sutures, held long, are now used to steady the duct while a longitudinal incision about $\frac{1}{4}$ inch in length, is made

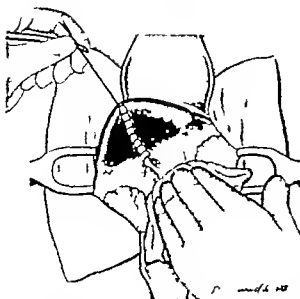


Fig. 6 The suture of the gall bladder bed completed. It is the site at which the lower end of the tube should be placed.

into it (Fig. 7, C). The line of the incision should be such that if it is extended upward it will extend along the cystic duct. Any bile which escapes is aspirated by suction and any stone which is situated beneath the incision is extracted with forceps.

The duct then is carefully palpated for calculi and by means of a malleable lead probe the duct and the hepatic ducts are gently explored (Fig. 7 D). By means of a blunt scoop any stones present are removed. The probe is then passed into the duodenum. The surgeon having made certain that no calculi are present, the sphincter of Oddi is carefully dilated (Fig. 7 E). This is done by the passage of graduated single-ended metal Hegar sounds (Fig. 7 E). No attempt to overdilate the sphincter must be made. Graduated sounds should be used and the largest size used should pass easily down the duct. Finally with a sound *in situ* the duct is again carefully palpated. The mere passage of a sound into the duodenum cannot be taken alone to exclude the presence of stones in a dilated common duct.

Stones in the lower parts of the duct can usually be scooped out or milked by the fingers into the upper part of the duct. Stones impacted in Vater's papilla can usually be gently coaxed into the duodenum. Either of these procedures must be carried out with great care. If bile sand is

present it may be washed out of the duct with saline solution introduced through a soft rubber catheter. It is rarely necessary to open the duodenum for the extraction of a stone from Vater's papilla or from the lower part of the duct. It does so adds considerably to the gravity of the operation. It should be attempted only after the methods described have failed.

The wound in the common bile duct is now sutured with fine gut (Fig. 7 F). Some surgeons prefer fine silk. Over this, if possible, is sutured the peritoneum, sufficient space being left for the escape of any bile which may seep through the suture holes.

A decision must now be made whether to perform a cholecystectomy or a cholecystostomy. The usual practice adopted in these cases is to perform a cholecystectomy. Drainage is important. It has been the practice never to place a drain within the common duct. The most careful attention, however, is given to drainage of the area adjacent to the opening in the duct. One and frequently two tubes are passed to this site, one through the upper angle of the wound, the other through the right loin. Experience has shown that when two tubes have been so placed at times one tube and at other times the second tube carries the greater drainage. The provision for the effective drainage of bile is most important and greatly minimizes the danger. In all cases in which the common duct has been opened however dry the wound or perfect the closure may appear drainage of bile must be anticipated.

CHOLECYSTOSTOMY

Cholecystostomy, which was formerly employed for the treatment of gall stones, has now largely been replaced by cholecystectomy. It is frequently followed by recurrence of symptoms and of calculi. It should be reserved for those cases in which cholecystectomy is contraindicated by the general or local conditions, and should be carried out in bad risk patients or in acute cases in which adhesion and infiltration of the mesentery of the cystic duct are present and in which cholecystectomy is judged to be dangerous.

The gall bladder is exposed and the contents of the gall bladder are removed as previously described. If the removal of the contents in these cases, considerable difficulty is not infrequently experienced with one or more small stones impacted in the cystic duct or in Hartmann's pouch. These stones may easily be overlooked if not carefully sought for and failure to remove them results in a persistent mucous

fistula. If they cannot be reached with the scoop or milked up by the fingers, either an incision should be made over them or the lower border of the gall bladder should be completely split down until they can be removed.

After removal of the stones, a long wide rubber tube should be placed to just below the midpoint of the gall bladder and fixed by a stitch to the fundus. The purse-string suture previously inserted is tightened and a second purse-string suture is inserted in such a way that the wall of the gall bladder may be invaginated. If the gall bladder is grossly thickened it may not be possible to insert this second purse-string suture, in these circumstances, a number of interrupted sutures should be placed on each side of the tube. The gall bladder is not sutured to the abdominal wall. The gall-bladder rest is lowered and a stab wound is made at the point on the abdominal wall close to the costal edge where the gall bladder comes in contact with it. The tube is brought through the stab wound and fixed by a stitch of silkworm gut. The end of the tube is left long and brought out through the dressings. The application of a clamp to the end of the tube is particularly dangerous and may result in the escape of a considerable quantity of bile into the abdominal cavity. The area near the cystic duct may be drained by a second tube through the upper angle of the wound if it is thought necessary. The abdominal wound is closed as previously described.

POSTOPERATIVE COMPLICATIONS

The main dangers of cholecystectomy arise from attempts to perform the operation in unsuitable acute or subsiding cases, when the mesentery of the cystic duct is thickened and indurated and anatomical landmarks are not clear, or in cases in which satisfactory exposure of the cystic-duct area is not obtained.

Apart from those complications which ordinarily may follow any abdominal operation, the special postoperative complications may be due to local or general bile peritonitis, the result of non drainage, inadequate drainage, clamping drainage tubes slipping of the ligature from the cystic duct, unsuspected injury to the bile ducts, the presence of unrecognized accessory ducts, or an escape of bile from the gall bladder bed. Serious complications may follow bleeding from the cystic or hepatic artery, injury to the portal vein or unsuspected ligation of the right hepatic artery or the common bile duct. Bleeding may also occur from the liver from adhesions which have been separated or from the omentum. When dense adhesions are present injury to the trans-

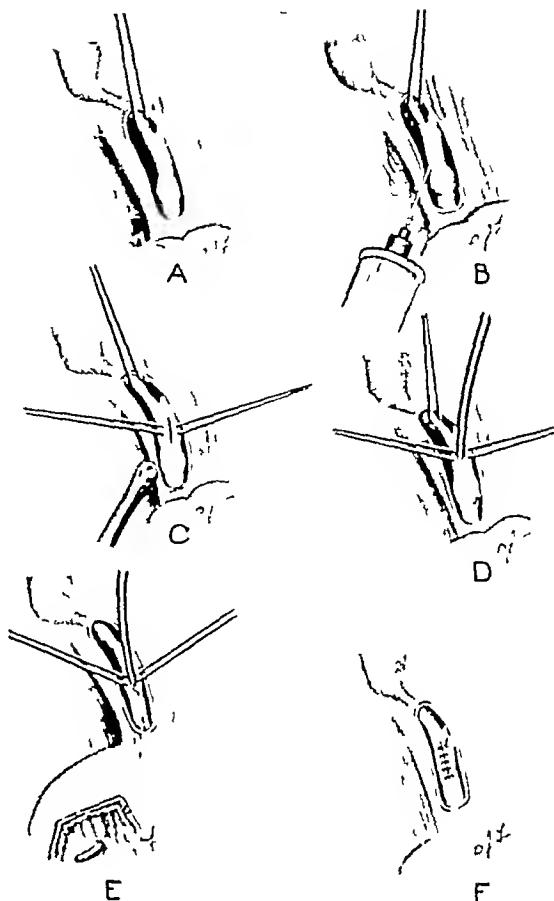


Fig 7 Cholechochotomy. A ligature has been passed above the cystic duct for retraction and the common duct has been exposed, A. A needle has been inserted into the common duct and some bile withdrawn. B, silk sutures have been placed through the coats of the common duct and the incision made into it. The line of incision should if extended upward, pass on to the cystic duct and not as shown in the diagram, C. The ducts are explored. D, and small graduated dilators are then passed. E. The wound in the duct is then sutured, F.

verse colon, the duodenum, or the stomach may occur. In addition a persistent mucous fistula may follow cholecystostomy if a stone is left in the cystic duct and cholangitis, infection of the liver, or stricture of the duct may follow cholechochotomy.

ADJUTANT TREATMENT

After recovery from the anesthetic the patient is treated in a sitting up position for from 2 to 10 days, depending upon his condition and the circumstances of the recovery. Deep sutures are removed on the eighth day and superficial sutures

on the tenth day provided there is no wound infection and the patient has no cough. In such cases the sutures should be left another 3 to 4 days.

The removal of drainage tubes depends upon the conditions found at operation. In the after treatment of patients in whom there has been merely a little oozing of blood the tube is removed several days after operation. It is the rule to shorten tubes 1 or 2 days before removal. In others, tubes of the same length but of lesser

caliber are inserted. If there is much drainage the tube may be left in for 5 to 8 days. In all cases in which there is drainage of bile the tube is left in for 8 to 10 days. When two tubes are used the tube which is not draining is removed. After cholecystostomy the stitch in the tube is removed on the tenth day and a safety pin is inserted, but no attempt is made to loosen the tube. The next day shortening of the tube is begun until it is removed. The patient is allowed to be up in from 14 to 16 days.

A NEW PLAN OF ANTECOLIC DUODENOJEJUNAL ANASTOMOSIS

FRANK H LAHEY, M D, F A C S, Boston, Massachusetts

ONE of the most difficult problems with which at times I have had to deal has been the satisfactory restoration of the alimentary canal after resections of the jejunum at such a high level that following the removal of the upper jejunum either for jejunal ulcer or annular carcinoma there remained such a short intraperitoneal jejunal stump that lateral anastomosis was impossible and end-to-end anastomosis unsatisfactory and even unsafe. When subtotal gastrectomy together with jejunal resection must be done for jejunal ulcer in a patient upon whom a no loop gastro-enterostomy has been done the remaining upper end of the intraperitoneal jejunum is often distressingly short. It is often so short that if an end-to-end anastomosis is made the upper stump of intraperitoneal jejunum is so used up by the anastomosis that the suture line is retracted up to or beneath the mesenteric root and obstructed by pressure from that structure.

A similar difficulty arises when an annular carcinoma of the high jejunum must be resected as shown in Figure 1 and in the diagrammatic illustration of such a case in Figure 2. As may be seen in Figure 2, the problem with which I had to deal in this case was that following the removal of the annular malignancy of the jejunum with adequate

amounts of normal jejunum on each side of the lesion there remained such a short intraperitoneal jejunal stump that safe anastomosis of the remaining jejunal ends was impossible. As the result of this dilemma the procedure here described and illustrated was conceived and employed. It has since proved valuable in high resection of the jejunum for gastrojejuno-colic fistula. It is described with the possibility that it may prove useful for others who find themselves in the same predicament.

In Figure 1 the x-ray picture demonstrates the high level of the almost completely obstructing lesion. Figures 2 to 5 demonstrate quite satisfactorily the technical steps of the plan of procedure.

From the Department of Surgery The Lahey Clinic.



Chart 1 The postoperative chart in the case presented in these illustrations



Fig 1 This roentgenogram of the first case in which this plan was employed shows the dilated jejunum and stomach above the high level of jejunal obstruction from an annular carcinoma of the high jejunum. The actual level of obstruction is not shown in this picture since its retrocolic position is overshadowed by the dilated stomach, duodenum, and upper jejunum.

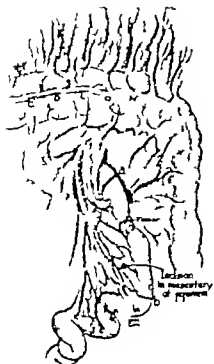


Fig. 2

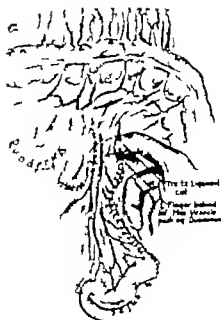


Fig. 3

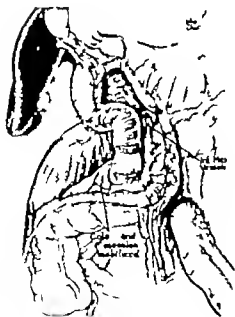


Fig. 4



Fig. 5

(Legends on opposite page)

CLINICAL APPLICATION

This operative plan has been satisfactorily employed in a patient with a gastrojejuno-colic fistula in whom it was necessary to resect the stomach, jejunum, and the right half of the colon up to the splenic flexure. It proved even more feasible in this case since following the removal of the transverse colon the jejunal stump could be transposed beneath the mesenteric root and a lateral anastomosis made between it and the lower

jejunal stump without the necessity of carrying the two ends in front of the colon.

While one may with this operative plan employ either lateral or end-to-end anastomosis I have preferred the former because with it there is less even temporary high jejunal obstruction, a factor which even though it may be only of temporary character can swing the balance in the post-operative recovery of serious cases in an unfavorable direction.

Fig 2 This semidiagrammatic drawing demonstrates the location of the carcinoma in the upper jejunum. Lines *a* and *b* together with the dotted lines demonstrate the amount of jejunum which it was necessary to remove together with its attached mesentery. The shortness of the remaining intraperitoneal jejunal stump as relates to a safe end to-end anastomosis reveals very well the dilemma in which I found myself. It was readily appreciated from past experiences with high jejunal resections and anastomosis in patients who had developed jejunal ulcers after no loop gastro-enterostomy that no safe anastomosis *in situ* between the ends of remaining jejunum could be accomplished. To meet this situation the plan presented in the following illustrations was undertaken.

Fig 3 In this illustration are shown both ends of the jejunum inverted and safely closed with mattress silk sutures. The parietal peritoneum about the ligament of Treitz and the point where the jejunum becomes retroperitoneal is shown incised about the jejunum so that that structure could be pushed behind the root of the mesenteric vessels into a retroperitoneal position. Following the with

drawal of the finger from the retroperitoneal peritoneum the remaining slit in the parietal peritoneum was closed by suture.

Fig 4 In this illustration the lateral parietal peritoneum beside the hepatic flexure is shown incised and the entire hepatic flexure with its attached mesentery so turned down that the retroperitoneal duodenum together with the mobilized and transposed stump of jejunum is at once visualized. With freeing of the retroperitoneal duodenum from its bands of retroperitoneal tissue it will be found to have a sufficiently long mesentery so that it can be carried in front of the transverse colon when that structure is restored to its normal position by putting the hepatic flexure back to the point from which it was mobilized.

Fig 5 In this illustration is shown the lower loop of jejunum and the upper loop of transposed jejunum and mobilized retroperitoneal duodenum carried in front of the transverse colon and continuity restored by lateral anastomosis. Note the slit made in the omentum to prevent pressure from that structure on the mesentery of the lower jejunal stump.

REPAIR OF THE INCONTINENT SPHINCTER ANI

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THE purpose of this paper is to evaluate the present concepts of the surgical repair of the incontinent anal sphincter and to make a preliminary report of a new principle of approach which has proved superior in our hands. We have used our operation in a case in which the orthodox procedure failed miserably the latter in this particular instance serving as a sort of control for having been attempted in our own hands we have used it in a case in which the usual operation would have been impossible of successful accomplishment (Fig. 4) and we have used it as a primary operation of choice. In our admittedly limited series, which is comprised of cases of only the predominant types of injury we have achieved in every instance an end-result which is not a compromise makeshift of indefinite classification but a restoration of physiological function indistinguishable to the patient from the original normal condition. Yet withal the operation is simple in plan and execution.

From a statistical study of 33 cases compiled from a questionnaire submitted to members of the American Proctological Society it was readily seen that with but isolated exceptions an incontinent sphincter and follows either obstetrical or surgical operations. Noteworthy as constituting a particularly serious indictment against surgery is the large number of cases in which the condition was brought about by a simple incision of an acute perianal abscess or by uncomplicated hemorrhoidectomies without exception the sequelae were entirely preventable and completely unforfeitable. In 69 cases, or 51 per cent of the total the condition followed fistulectomy and this was by far the most important single cause. Rarely are such experiences unobtainable in the hands of a competent operator and but few proctological experts have ever been the instrument of their occurrence. We cannot speak for the obstetrician, who has much to answer for but other wise certainly with but few obvious exceptions, the series represents the fruits of incompetence.

The vulnerability of the anterolateral quadrants to tragic operative injury in women is unmistakably indicated by the marked preponderance of such cases, in spite of the fact that fistulas occur more commonly in other sites. The fact that the injury occurred directly posteriorly in

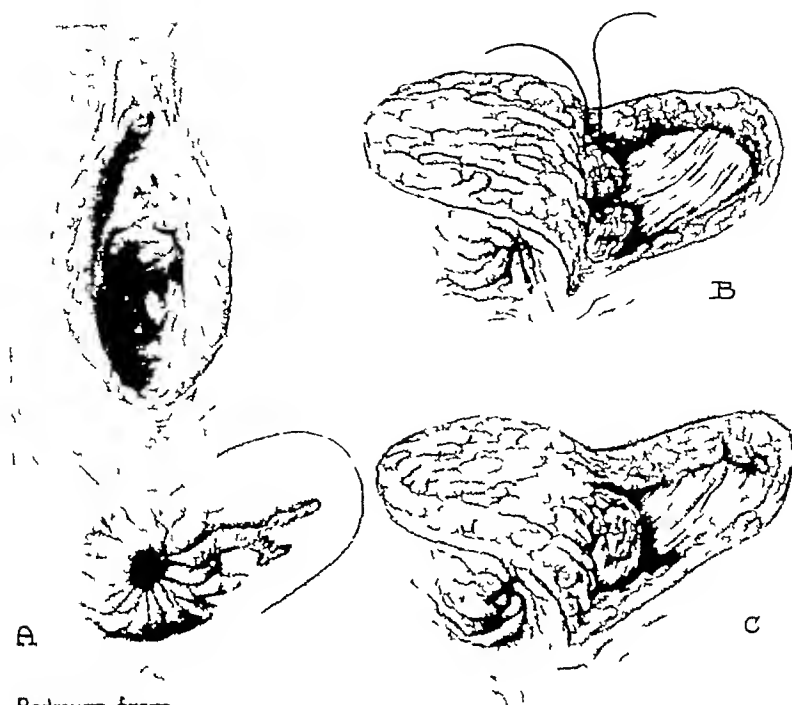
15 cases, a site often mistakenly regarded as immune to such consequence (1-3) should also be a warning.

In this series the usual procedure of freeing and uniting the ends by suture was used, as shown in Figure 1. However the results (Fig. 2) indicate that the apparent simplicity and adequacy of the operation as suggested in texts and pictures is apt to prove illusory even in the hands of experts. Certainly any surgeon whose inadequacies have served as the inception of incontinence is not the one to extricate himself from the predicament by this operation. Such attempts, frequently multiple, have too often provoked that despair in the patient which has proved a deterrent to further surgery in more competent hand or has superimposed added difficulties to possible final correction. It is evident that the optimistic descriptions in the literature are not justified and that the operation leaves much to be desired.

It is noteworthy also from the statistical study that the obstetrical cases fared distinctly better than those of the "surgical" group, thus indicating the lessened incidence and virulence of infection in intravaginal procedures as compared to those through a skin approach. Seventy per cent of the series were reported as having exhibited varying degrees of infection and this obviously constitutes the most devastating circumstance inimical to plastic surgery of this region.

In our own experience with this operation all details against postoperative infection which we could find reported or devise ourselves have been without avail none of our cases remained entirely clean. These precautions have included studied pre-operative and postoperative care the lifting of a wide flap to the site of repair the absence of any intra-anal palpation or any finger contact with the wound and the discarding of all instruments once used. While, as a rule, the absence of outcome varies in entirely with degree of infection, occasionally even the worst infection did not prevent a favorable outcome. As this fact has an interesting implication we shall allude to it later.

Next in importance to the overwhelming hazard of infection as an explanation of unsatisfactory results is the difficulty in dissecting out the frayed muscle ends buried in scar tissue. Apparently a simple task in pictures, it is more often than not



Redrawn from
Nelson's Loose Leaf Surgery
Vol. V - Chapter 3

Fig 1 Usual plastic operation for repair of the incontinent sphincter ani. Attention is directed in the text to difficulties with what here appears to be a simple and adequate procedure

insuperable to those whose anatomical and surgical familiarity with the region is limited largely to reference sources and occasional operation. Indeed, this inherent difficulty has occasioned the belief by some that atrophy of muscle tissue must occur. While such an assumption is not outside the range of possibility, it is not supported by the consideration that the duration of incontinence in this series before attempted repair was found to have no bearing on surgical prognosis, for time is the essence of such atrophy. Furthermore we have experienced this difficulty of identification only to find easily perfectly normal muscle on subsequent attempt at an unimpaired site, as we shall later report. And, if enough muscle is dissected out to insure proper identification and apposition, and without too much tension, one encounters the opposed problem of final stenosis.

These two insurmountable defects then are connate with this type of operation and, admitting inevitable sources of failure, must remain barriers to uniform and dependable success. This is true from a theoretical standpoint and in the light of our statistics relative to the method.

Buie has recently formulated a new method of attack which is deserving of comment. In his opinion the loss of constricting power is due almost exclusively to extended postoperative packing, with its resultant interposition of excessive scar. He advises that it is only necessary through simple excision of the scar tissue to recreate the cavity which existed immediately following fistulectomy, then to allow the wound to heal by granulation without recourse to the muscle suturing of the more difficult orthodox operation.



Fig 2 End results in our reported series with operation shown in Figure 1

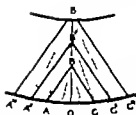


Fig. 3 Schematic representation of suture of sphincter and showing results of operation. Injury Niche ABC represents retraction following incision OB and is assumed to be too small to cause even temporary incontinence. The latter is prevented by the splitting effect of the unsevered portion and fortunately represents the most common situation. Niche A B' C' could similarly follow incision OB' and is assumed to be of sufficient magnitude to cause temporary incontinence. Here the deficiencies of splitting due to too deep severance could be sufficiently counteracted by the contraction of scar tissue during normal healing as to result in the dotted niche A B' C' by which continence would return as the final result. By prolonged postoperative packing, however, which could prevent this contraction, the niche A B' C' could remain unchanged and the temporary incontinence become permanent. The niche A B' C' represents the result of incision OB and by similar reasoning, even if normal healing were permitted it could not overcome the handicap of deficient splitting due to too deep severance and even the optimum end result A B' C' could mean final incontinence. Thus, theoretically only in certain cases does packing make the difference between continence and incontinence. Only in those, in which lack of splitting due to too deep or multiple severance has not been a factor, could re-creation alone of the original sound, and this time with correct postoperative care, cure the incontinence. As the factor of packing is often difficult of determination from either the history or examination there would seem to be difficulties in the proper selection of cases.

A study of Figure 3 will show in theory how the effectiveness of this type of procedure depends upon the rôle of excessive postoperative packing.

Although we have not tried the Bure type of operation as such, it is theoretically possible that in cases due chiefly to prolonged postoperative packing superior results might be obtained. Indeed, one probably unwittingly effects this operation not infrequently during his execution of the usual plastic repair. This is in view of the high incidence of infection and the inevitable sloughing of sutures and tissue. That good results have been obtained on such occasions is probably evidence favorable to the simpler operation.

According to the replies to our questionnaire nearly all cases can be classified in 3 groups according to causes, namely: in order of importance too deep severance, multiple severance and excessive postoperative packing. These are commonly asserted in the literature but there analysis has stopped. Possibly arrested because so simple, it must be recognized that there is a still more

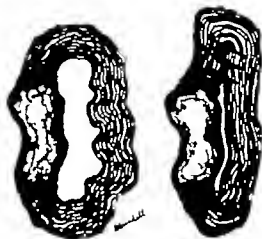


Fig. 4 Schematic representation of muscle reefing operation for the incontinent sphincter and actually this closely represents the condition in our second case report. In this patient the scar had replaced such a large segment of the muscle due to repeated operations that satisfactory direction and suture of the muscle ends after removal of the scar could have resulted in far too small an anal outlet. On the other hand, reefing of normal segment of muscle was easily accomplished and its excellent result.

basic factor common to all these—a fixed and safe increase in the circumference of the anus. The importance of this dictum lies in the now obvious implication that any procedure which can be found to decrease the circumference, whether directed at the point of injury or elsewhere might benefit all patients with incontinence regardless of the causative mechanism.

Furthermore it is essential to our thesis to point out the erroneous assumption as to the pathological physiology interpreted in relation to the abnormal mass of scar tissue—aside and above its rôle of increasing circumference by separating the muscle ends. That is, additional interference has been ascribed to the deformity occasioned by the mass of scar tissue *per se*. True this concept has been hardly more than nebulous as far as any actual formulation has been concerned, but none the less operative as the focal point of remedial surgery. It has largely shaped both types of operation under discussion for these have been predicated on the removal of this scar tissue as an absolute essential. In some manner not made clear and variously expressed—or unexpressed—the scar tissue interferes with contraction of the muscle on strif. From all consideration and context the comparison may be fairly made to

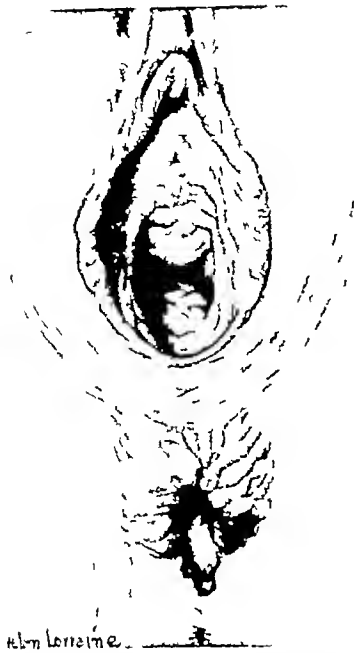


Fig 5 Vaginal incision for reefing operation Scar at the site of original injury is here shown directly posterior and represents the actual condition in our first case Immediately after the incision the anus is draped with a towel caught in the grasp of Allis forceps on the lower flap The wound is deepened to the external sphincter ani which is first separated from subjacent tissue by blunt dissection with the knife handle Grasped then with Allis forceps and with tension directly anteriorly the muscle band is readily separated down the sides

the hindrance of a golf ball in the hand to complete closure of the fist

It seemed to us on closer analysis that closure of the muscle *on itself* was not the decisive point, but rather that it closed on *something, even scar tissue*, that in the comparison with the golf ball in the hand, tight closure of the fist was not so pertinent as the effective apposition of the surface of the hand to the surface of the ball (Fig 4), and thus, that if the slack were taken up by *any* method there would be improvement in function whether or not the scar tissue remained That we have had success in the application of this principle is evidence of the verity of our premises

Herewith is proposed a technically far easier and yet withal more effective type of operation which applies our theoretical premises and almost completely eliminates the demonstrated deficiencies of other operations It is so simple in both concept and execution as to occasion surprise if it has not been utilized before, although no reference is found in application to the general

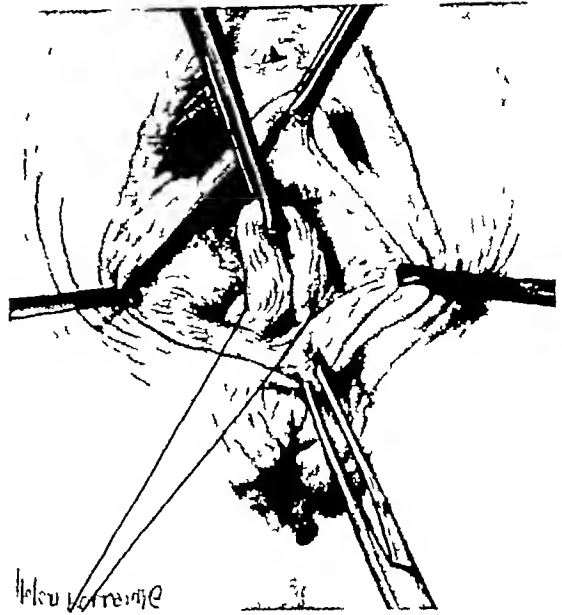


Fig 6 Reefing operation, showing placement of first chromic suture through external sphincter In our cases we have aimed at overcorrection, and the results point to the wisdom of this Non absorbable sutures should not be used, and no sutures throughout the whole operation should be tightly drawn

problem, at all events, any extended familiarity or use is certainly negligible We attempted it first after an utter failure of the usual plastic operation, and success was so dramatic and the patient so completely rehabilitated as to make it the primary operation of choice on subsequent occasions Advantage is taken of a direct attack on the *anterior normal* portion of the external sphincter rather than on that portion mutilated by operation and deformed by scar tissue—heretofore utilized (Figs 4, 5, 6, and 7) A reef is taken in the muscle, through the vagina in all of our small series, so that the circumference of the whole muscle and of the anal outlet is diminished Dependence is placed exclusively on this effect with entire disregard of the scar tissue

This operation not only largely eliminates the basic sources of failure of the other operations but its advantages are strikingly positive as well The following differences merit emphasis

1 Disruptive infection is favorably affected in a large proportion of the surgical group by the substitution of clean vaginal approach rather than through the perianal skin As this group comprises 85 per cent of the total in this series, about three-fourths of them females, the significance of this advantage is evident

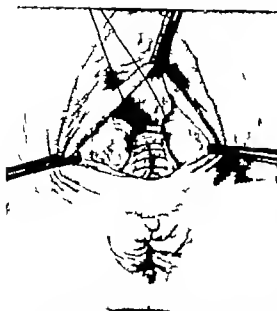


Fig. 7. Reefing operation: muscle reefed and suture placed in lateral incision for turning down reefed portion, and held slight upward tension. The incision is best tightly closed with few interrupted sutures even these should be removed immediately if any indication of infection should develop.

The procedure entirely obviates what is often the most difficult and yet essential step of the usual plastic operation, that is, accurate and adequate identification and dissection of the frayed ends of muscle buried in scar tissue. It substitutes, therefore, an approach to a normal and undivided muscle through normal and undisturbed tissues, a far easier course.

3. The success of any operation depends on the proper balance between tension of the muscle immediately following suture and the circumference of the anus in the final result. If there is too much tension the sutures will not hold. In other operations this is entirely predetermined by the amount of scar tissue mass to be removed and hence is entirely uncontrollable unless one takes a chance with resultant stenosis. Indeed, there are numerous instances, of which our second case is an example wherein after repeated clumsy rectal operations, the scar tissue occupies such a large part of the anal circumference as to prohibit any possibility of success following removal of the mass. With our operation on the contrary the opposing factors of tension and stenosis are entirely controllable and in our illustrative case representing conditions at their worst there was absolutely nothing added to the difficulties, either

In the way of technical accomplishment or to the securing of an excellent result. Of course replacement of over half of the circumference of the anus by scar tissue would impose an unsurmountable limitation.

4. There is augmentation of muscle area in apposition, of better quality and arrangement to hold more effectively during the period of healing.

In the obstetrical group the orthodox plastic procedure has proved more nearly satisfactory and would seem to take precedence over muscle reefing for in these cases attack on any normal portion of muscle would of necessity be shifted to the perianal skin. This approach might be utilized if further attempts seemed desirable. In other words, vaginal approach is probably more salutary if one must choose than approach to uninjured muscle.

Incontinence in the male occurs less frequently but the same advantages enumerated hold true except that of course anterior approach cannot be vaginal. Even so, the danger of infection following operation is considerably less in this site than posteriorly due to habits of cleansing after bowel movements, and to the direction of soiling.

Our clinical experience with this type of operation is limited to 3 cases so that this feature must be considered in the light of a preliminary report. We prefer to make it at this time rather than delay a more seasoned report because the procedure is theoretically sound in concept and simple in execution so requiring nothing of a "stunt" because our results have all been successful and, lastly because even in the large amount of clinical material at our disposal these cases are so occasional that considerable time would elapse for any extended series.

Our first case a nurse was utterly incapacitated and confined to her home because of absolute incontinence following a fistulotomy 6 years previously. A plastic had been attempted elsewhere and we ourselves had performed the orthodox operation for the defect in the midline, posteriorly. Complete failure was due chiefly to gross infection. Six months later we performed the reefing operation, our first experience and with truly dramatic result. Completely rehabilitated she regards present control not just as an improvement but as normal as ever before the onset of her protracted rectal difficulties, even as regards escape of gas.

Following this successful outcome we were encouraged to perform the operation in our second case likewise a nurse with a history of 7 operations elsewhere to repair a fistula. She possessed no control of flatus or soft stool and even with

constant care in choosing foods the fear of accident limited her activities by the necessity of ready access to a toilet. As nearly the entire right side of the sphincter was replaced by scar tissue (Fig. 4), removal of the latter would have meant inevitable failure. After our simple operation, however, she regained complete control even to the passage of gas, she does not have to watch her diet, and she can readily control the most urgent desire to defecate. The condition is no longer a matter of primary concern in her life, her existence is correspondingly happier and more useful.

The third case, a housewife aged 50 years, complained of her inability to control movements and total uncontrol of gas, since a fistulectomy a year previously. Also for several years she has had slight seepage of rectal contents into the vagina, antedating her present rectal history and of undetermined origin. Examination revealed a pin hole sized rectovaginal fistula just above the sphincter ani and a defect of the latter muscle in

its right anterior quadrant. Reefing of the external sphincter was accomplished after plastic repair of the septum. Function has been restored completely.

SUMMARY

An evaluation of the usual plastic operation for repair of the incontinent sphincter ani is presented, based on a study of a series of 133 cases compiled from a questionnaire submitted to members of the American Proctological Society.

The theoretical basis, advantages, and technique of a reefing operation for the incontinent sphincter ani are presented and discussed.

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THE REPAIR OF DEFECTS OF THE FRONTAL BONE

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PATIENTS who have deformities of the face seem, at times, to suffer from mental depression that is out of proportion to the extent of the deformity, due to their avoidance of social contacts and the difficulty of obtaining many types of employment. This seems particularly true of patients who have defects of the frontal bone. Reconstructive surgery has been a great aid in rehabilitating these patients.

Defects of the frontal bone require correction for cosmetic reasons and for the alleviation of the symptoms that are due to absence of the full thickness of the skull. In the cases that we have operated on they were performed to correct the defects largely from a cosmetic standpoint.

Defects of the frontal bone may be congenital due to persistence of the frontal suture, post operative defects secondary to intracranial or extracranial operative procedures, osteomyelitis and trauma. The extent and contour of the disfigurement vary greatly so that only rarely does one see two similar deformities. Malignancy of the frontal region, as in other situations, requires complete removal regardless of the resultant deformity and with periosteal involvement a sequestrum frequently results. Frequently the deformity that one sees in the frontal region is the bony defect secondary to removal of a sequestrum after treatment of an epithelioma by irradiation or surgical diathermy (Fig. 1). In the treatment of osteomyelitis of the frontal bone, there is a difference of opinion as to the advisability of conservative or radical treatment. The resultant deformity of course is of secondary importance and can be safely corrected only after healing is complete (Fig. 2). In general it is best to wait for at least 6 months until the thickening and scarring have subsided. Radical surgical procedures for empyema of the frontal sinus or abscess of the frontal lobe are a frequent cause of deformity in this region. The frontal bone and the supra-orbital ridge may be pushed backward as the result of trauma. A common deformity due to an automobile accident is the displacement of the base of the nose the glabella, and supra-

orbital ridge which have been driven backward into the ethmoid region (Fig. 3). The patient is usually in a critical condition and any attempt at immediate replacement of the displaced bones might result in meningitis. Healing is permitted to take place and the deformity is corrected by secondary plastic procedures. In the healing of defects of the skull, perosteum grows downward over the shelf of bone and becomes adherent to the dura, so that an irregular contour of the skull is produced. This complete covering of the margins of the bone prevents the production of callus which ordinarily would fill and obliterate the defect.

TREATMENT

The time of correction of the defect of the skull must depend on the etiological factor in its production. It is always best to wait until complete healing has taken place until any sequestrum has been removed and if any abscesses are present until all discharge ceases. Six months from the time of the last operation or the accident in general is the time of election. If the deformity is secondary to malignant disease it is best to wait for at least a year. If the periosteum has been involved, it must be sure that there is no recurrence. When the patient presents himself for reconstructive surgical alteration of a defective frontal bone of any extent, it is best to make a cast of the face, so that the defect may be built up in clay and the extent of the deformity determined. From the cast, lead patterns are obtained, both of the surface defect and of the depth of the defect. These may be taken to the operating room and used at the time of the reconstruction. It is essential that the patient be in the best possible general condition. If there is severe wide scarring or displacement of the hairline or eyebrows, this should be corrected first by excision of the scars and adjustment of the soft parts. Correction of the contour consists of inserting some type of tissue to fill the defect. Artificial material such as gold, silver or ivory and celluloid has been employed but we do not feel that any foreign material has a place in this type of work.

Richard and Macewen and Lexter used dog bone and cow bone but these were absorbed and

From the Section on Laryngology, Oral and Plastic Surgery,
St. M. Clinic.
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Association, New York, May 16-20, 1937.



Fig 1 Repair of defect in forehead, a, postoperative defect of the frontal bone following removal of a malignant tumor a year previously. The sequestrum was removed but, due to the sclerosed bone, granulation did not come through in usual manner, b, a flap with the pedicle above

the defect was turned from the left side of the forehead to cover the exposed bone and a skin graft was used to cover the area from which the flap was taken, c, immediate result after removal of the sutures

did not permanently correct the deformity. Soft tissues, such as fat and fascia lata, may be used for small defects but we have found that cartilage and bone are the best materials for this purpose.

Free fat transplants have been used as the media to fill the defects of the frontal bone

Harter, in 1927, reported a case in which the defect was repaired with multiple, small grafts placed at several different sittings over a period of months. Fig1, in 1931, reported a successful result, 13 months after operation, by the use of a large, single, free, fat transplant, overcorrecting

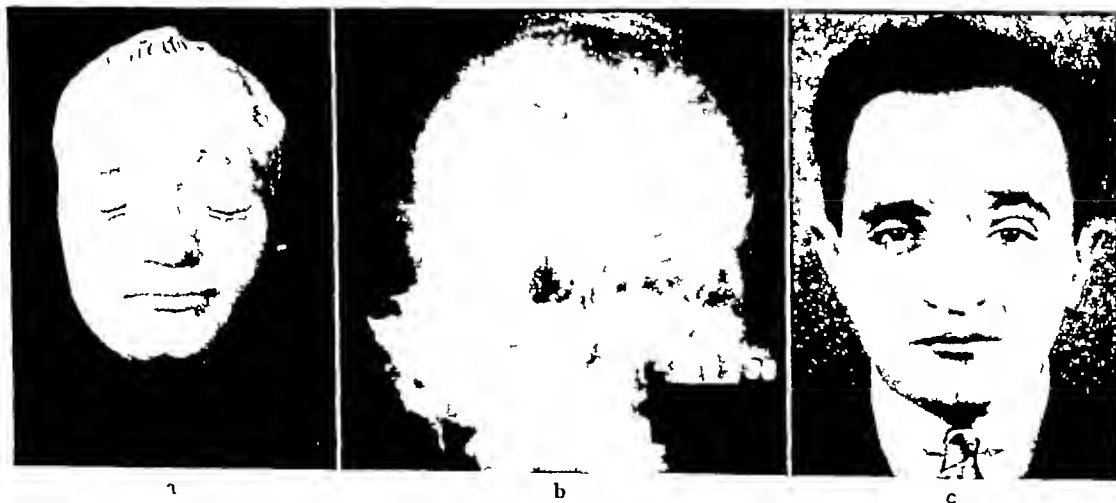


Fig 2 a, Cast showing the defect of the frontal bone secondary to operation for abscess of frontal lobe, b, roentgenogram showing the extent of the bony defect, c,

postoperative photograph 8 months later. The defect has been corrected with rib cartilage and the scarring of the forehead excised and the eyebrow adjusted



Fig. 3. Repair of defect of frontal bone. a, Cast showing defect of frontal bone of traumatic origin, b, roentgenogram showing the extent of the bony defect, c, photograph

which was taken six months after operation in which cartilage grafts were employed in order to correct the deformity present.

at the time and thus allowing for partial absorption. Gurney in 1938, in an experimental study on rats showed that only one fourth to one-half of the free fat transplants survive and that multiple pieces, in lieu of a single piece of equal bulk is not a satisfactory procedure.

Fascia lata may be wadded into a shape that corresponds with that of the defect and may be inserted to restore contour. This is only applicable if the depression is slight. Being of a fibrous nature fascia lata will remain as such or will be replaced by a similar substance and, therefore only little overcorrection is necessary.

John Hunter (quoted by Keith) did much pioneering in bone grafting but did not obtain good results due to the lack of knowledge of

asepsis. Paul Mueller first used the pedicle sternum flap to restore cranial depression. Koenig and Mueller later executed a skin osteoperiosteal flap from the neighboring outer table of the skull, with fascia lata interposed to prevent adhesions between the brain and the bone graft. Hacker and Durante used an osteoperiosteal flap of the outer table twisted on a pedicle so that the periosteum contacted the dura or brain tissue. Both methods had the dangers of encountering severe hemorrhage and causing cerebral injury during the splitting of the outer table from the inner table.

Free bone grafts were employed with good results for these defects, from the scapula (Leclerc), the tibia (Delagenière) the rib (Kahle) and the greater trochanter (Mauclair). Sterilized free cranial grafts from cadaver skulls were used successfully by Sicard, Dambion and Roger in 43 cases. Their grafts were 0.5 centimeter thick and perforated by holes 0.5 centimeter apart.

In 1865 Bert reported his conclusions regarding cartilage grafts in experimental animals. Thirty-one years later in 1896, Koenig first used autogenous cartilage grafts in man to repair partially destroyed tracheal and laryngeal cartilages. Costal cartilage was successfully used by von Mangoldt, in 1899, for the correction of deformities. Morestin of Paris, in 1916 described the cartilage graft for the repair of posttraumatic cranial defects. Villandre Rousier Woodroffe Gosset, Gilmour Henle Lexer Schmieden, Wilson, Loeb and others made contributions to the work of using cartilage as transplants.

Stored cartilage is obtained at the time of removal of rib cartilage. The material that is not

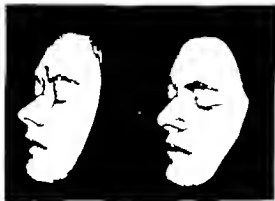


Fig. 4. a, left Traumatic defect of the frontal bone and nose secondary to automobile accident. b, cast showing defect in forehead and nose corrected. c, rib cartilage

used on that patient is stored in an aqueous solution of merthiolate or in a solution of metaphen and is kept in an icebox. It is used at times, particularly in the presence of infection as in the treatment of a nasal deformity when it is necessary to chisel away some of the nasal bones and refracture them from the inside of the nose, and then use a cartilage implant to elevate the dorsum.

TECHNIQUE

For the correction of a defect of the frontal bone the patient is anesthetized by the intratracheal nitrous oxide gas ether method. The hair is shaved well back of the forehead. A solution of novocain and adrenalin is injected for its hemostatic effect around the defect, if it is a large one. The incision is usually made above the hairline; in the eyebrow, or in an old scar if this seems advisable. The incision above the hairline may be just large enough to allow elevation of the skin and subcutaneous tissue over the defect or it may extend laterally to allow the turning down of a large forehead flap, thus exposing the entire defect. Cartilage is removed from the right side of the thorax. In selecting an area for the removal of cartilage, the site of the defect, its thickness, and extent determine from just what place the cartilage will be removed. The supra-orbital ridges require a piece of cartilage the shape of which simulates their outline and while the surgeon shapes the cartilage to conform to the pattern, the first assistant closes the donor site.

Cartilage is usually built up on the lead patterns and the larger pieces are sewed together with fine silk. These are inserted through the incision above the hairline. At times, these may be fixed to the frontal bone with small pieces of stainless steel surgical needles used as tacks. Catgut sutures are used to close the pericranium over the graft, and the scalp flaps are approximated with fine interrupted silk sutures. A dressing of gauze that will provide pressure is applied and maintained for 10 days. At times, in the type of deformity that is frequently seen as a result of an automobile accident, the glabella and nose as well as the forehead may have to be built up. In this type of case the accurate fitting of the cartilage to form the bridge of the nose and the glabella is very important (Fig 4). Little reaction, as a rule, follows insertion of cartilage and the cosmetic results in cases in which we have employed it have been very satisfactory.

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INTRATHORACIC GOITER

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IT is a curious coincidence that the first volumes of two famous medical journals, published in the years 1826 (Duboung) and 1828 (Adelmann) respectively, should contain what were probably the first reported instances of death resulting from strangulation by and malignant disease of an intrathoracic goiter. Since that time, many cases have appeared in the literature but it was not until the end of the last century that the condition was put on a familiar basis from the standpoint of pathology by Wuehrmann (1896), and that of diagnosis by Schiff (1899) one of the pioneers of roentgenology. Intrathoracic goiter is now sufficiently well known as a clinical entity for its presence to be considered in the diagnosis of every case of tumor of the upper mediastinum yet in spite of this apparent familiarity with the condition a perusal of the literature will show that considerable divergence of opinion exists in regard to the frequency of its occurrence. It would appear that the factor responsible for this irregularity is the lack of unanimity in the nomenclature which has been

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adopted for reference to the various clinical types. It is a matter of common experience in operations for goiter that, although the thyroid gland undergoes a general expansion in most cases, a good proportion of the enlargement may take place in a downward direction in a number of them. Indeed, it is probable that in almost half the cases one or other lobe dips down into the suprasternal notch, particularly in short-necked people or in those in whom the thyroid gland occupies an abnormally low position (thyropsois). At other times, the downward extension is more definitely retrosternal, but can be made to leave the thorax either by straining or coughing, or on extending the head. To this variety the term *struma profunda* was applied by Kocher and the title of intrathoracic goiter was reserved by him for those swellings of the thyroid gland in which some portion of the enlargement remained permanently retrosternal. The distinction was a good one and Kocher's definition was accepted for general use. In the course of the following years, however, a further modification was introduced. The intrathoracic goiters were differentiated into two types, the partial and the total, according to whether the major part of the swelling was situated above or below the plane of the thoracic inlet. Some authorities still further discrimination and would employ terms, such as lateral, median, pleural, subcervical, subclavicular etc. in order to emphasize certain minor anatomical variations in particular cases. It is doubtful however whether the employment of so many descriptive terms serves any useful purpose although the present system of classification leaves much to be desired. The term partial, as employed at present, is satisfactory enough so that it means exactly what it implies but it is not logical to apply the term total to a goiter which does not completely lie within the thorax. It is felt that this term should be reserved for those rare goiters in which the whole swelling lies within the chest, and that it should not be applied to those in which the major portion only is situated within the thorax, as is the present-day custom. In the present series of over 1,200 thyroidectomy cases, there were no more than 3 to which the term total could justly have been applied, although there were 20 in which the major portion



FIG. 1. Marked displacement of the trachea to the right
Case 8

of the swelling lay within the thorax. In order to overcome this irregularity of classification, without the introduction of new terminology, it is suggested that those goiters which are mainly cervical but which also possess an extension into the thoracic cavity should never be called intrathoracic goiters, but should be referred to quite simply as cervical goiters with a thoracic extension. The term "partial" could then be applied quite justly and without reserve to those goiters in which the major portion of the swelling lies within the thorax and the designation of "total" or "complete" to those in which, for practicable purposes, the whole goiter is situated within the thoracic cavity.

THE FREQUENCY AND SEX INCIDENCE

The general range of figures in the literature relating to the incidence of this type of goiter runs between 5 and 45 per cent of all thyroid enlargements. The tremendous discrepancy in these figures makes it evident that those observers who experience the higher rate of frequency in their

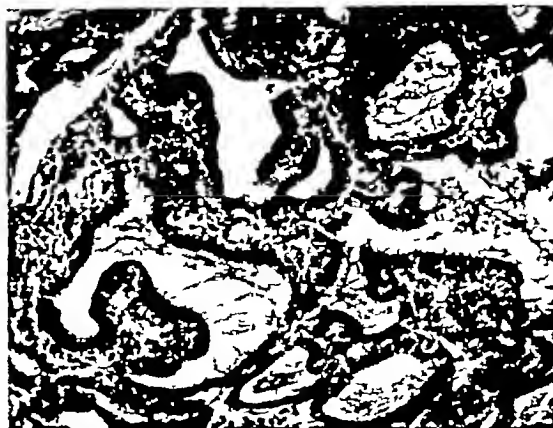


Fig 2 Photomicrograph showing a considerable degree of toxic hyperplasia. Case 1

practice must of necessity include many instances of goiter among them that would not generally be regarded by the majority of operators as being intrathoracic in type. However, those observers who adopt Kocher's definition of intrathoracic goiter show a relatively constant frequency varying between 10 and 15 per cent. In the present series of 1,265 thyroidectomies, there were 111 cases in which some portion of the goiter was



Fig 3 Infra red photograph showing dilated subcutaneous veins due to large substernal goiter. Case 19

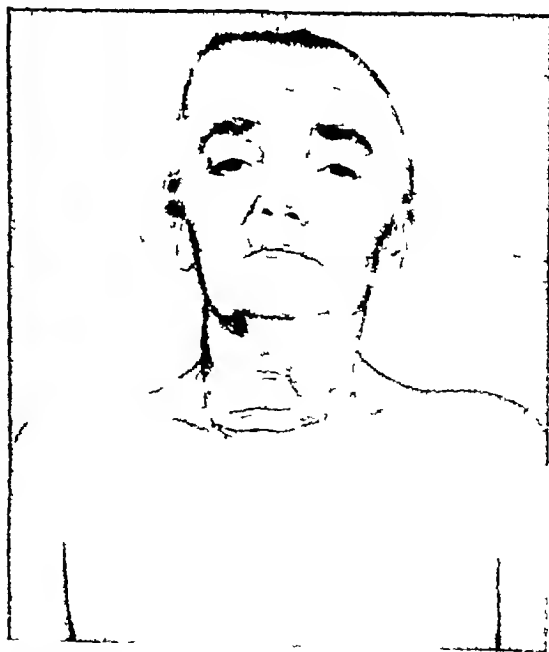


Fig 4 Infra red photograph taken 10 days after removal of large substernal goiter. The subcutaneous veins are hardly visible. Case 19



Fig. 5. Toxic intrathoracic goiter: note distortion of the trachea. Case 2.

permanently retrosternal, a proportion of 8.7 per cent. Of this number 9 were examples of cervical goiters with a permanent intrathoracic extension; 17 were cases in which the major portion of the swelling was situated below the plane of the thoracic inlet, and 3 were instances in which the whole swelling lay within the thorax. In the present day nomenclature, the 91 cases would be grouped as "partially intrathoracic, and the 30 remaining as 'totally intrathoracic, a description which cannot be considered satisfactory because it is indefinite and not very accurate. It is proposed, therefore, not to regard the 91 cases of cervical goiters with permanent intrathoracic extensions as instances of intrathoracic goiters, so that the remarks in this article will refer solely to those goiters in which the swelling was mainly or wholly within the thorax.

In the literature, the frequency of the total variety as we have outlined it here is not given, but figures relating to combined numbers of total and partial intrathoracic goiters (using the terms in their limited sense) have been given by Curtis (193) as being between 1 and 2 per cent, and by Croft (1938) as between 3 and 4 per cent. In the present series, the percentage for a similar group works out at just under 1.6 per cent, of which proportion .34 and 0.83 per cent refer res-



Fig. 6. Photomicrograph showing moderate degree of toxic acellularity. Case 2.

pectively to the partial and complete varieties.

With reference to the etiological factors of age and sex, it may be stated that they do not appear to be altered by the unusual situation of the goiter. In general, intrathoracic goiter is a disease of the middle-aged woman. The specimens are usually of the nodular variety and are the seat of cystic or the other types of degeneration which tend to be common about that period of life. In the present series, 2 patients were 25 years old and 1 was 62 years of age, but all the ages of the remainder fell between the thirty-fourth and fifty-fifth years. Thus, the average age incidence was just over 40, a figure which is possible on the low side but which may be related to the proportion of toxic cases in the series, comprising 7 of the total number of 30. Regarding the sex variations, there were only 2 men in the series, the proportion of females to males thus being 9:1. This ratio accords well with the general run of sex-frequencies for goiters occurring about the same period of life. In regions of endemic goiter the frequency of intrathoracic goiter tends to be higher than elsewhere possibly owing to the greater number of large thyroids which occur in those districts, the sex and age incidence remaining unaltered.

PATHOLOGY

The mode of production of an intrathoracic goiter is simple enough to understand, particularly in those cases in which a connection with the thyroid gland is retained. There is no doubt that the very great majority of thoracic goiters, including the total variety are 1) one time or another cervical in position, and that downward growth is favored by the resistance of the cervical muscles anteriorly and laterally and by the trachea and vertebrae posteriorly. The line of least



Fig 7 Large substernal nodule goiter which showed a mild degree of toxic activity Case 5



Fig 8 Photograph of intrathoracic goiter from Case 7 This specimen was mildly toxic Actual size

resistance is therefore downward, and the tendency to descent is also favored by the disposition of the infrahyoid muscles which serve as a guide into the mediastinum, and possibly also by the influence of actions, such as inspiration and swallowing, or by gravity. As the goiter progresses downward, its thyroïdal connections become attenuated and no doubt in a few cases completely severed, giving rise to the totally intrathoracic type. An independent blood supply is, however, retained in these cases. The possibility of aberrant growth is, we consider, doubtful, although feasible. In the early stages of development, the thyroïdal bud lies in front of the second aortic arch, coming later into contact with the aortic stem in the loose subpharyngeal tissue below the arches, thus the possibility of thoracic aberrant growth is a real one. Apart from surmise, however, there is no real evidence to support this theory, although Means (1938) mentions a case in which the goiter was resting on the diaphragm.

Intrathoracic goiter seems to originate with equal frequency from either of the lateral lobes or from the isthmus. When it originates from the latter, it usually deviates to one or other side as

it grows in size. Bilateral forms also occur and may reduce the trachea to a narrow slit. Ordinarily, however, the trachea gets pushed to one

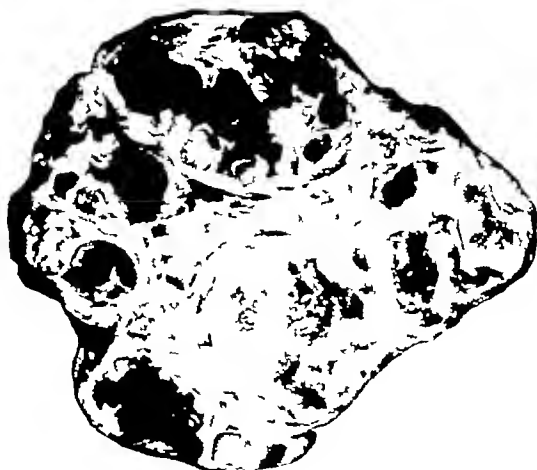


Fig 9 Photograph of retrosternal non-toxic goiter removed from Case 15



Fig Photograph of Case 20. A malignant adenoma.

side becoming stretched over the swelling (Fig 2) in rare cases, it may even describe a semicircle. The esophagus is affected to a lesser degree as it is less rigid and is situated more posteriorly. Occasionally, however, a goiter of this type may become retro-esophageal, particularly when it is located on the left side giving rise to marked dysphagia.



Fig Photomicrograph of Case 20. Malignant adenoma showing tendency to alveolar formation.

Rarely one encounters the goiter plongeant, a variety first described by Malard in 1851. This type of goiter received its name from the curious way in which it bobbed up and down in the thoracic inlet, sometimes disappearing within the cavity and later being expelled vigorously during an attack of coughing or in swallowing (Case 21). It is usually accompanied by much more subjective disturbance than the other varieties, particularly with what is usually called choking spells, and is, therefore, more likely to produce a fatal result on that account. Once the goiter has become intrathoracic its retention is favored by further growth, or by the development of degenerative changes or by a hemorrhage. In a small percentage of cases, probably between 2 and 3 per cent, malignant disease supervenes. Case 20 is illustrative of this phenomenon. When the gland is the seat of toxic changes, the character of these is of the usual type but milder in degree, showing an uneven spread of activity. One case in the series, however, showed changes which were typical of a very active toxic gland (Fig 3).

SYMPTOMATOLOGY

Trauma. Although the main features of all intrathoracic goiters depend upon the development of pressure effects on the structures which pass through the thoracic inlet, there is no doubt that there exists in a certain proportion of them an associated thyrotoxicosis. There is little reference in the literature to this side of the question and the reason for this apparent oversight may be that the toxic manifestations are often mild in degree and are due in part to a coincident increased activity of the normally situated thyroid gland. In such cases, the symptoms are alleviated



Fig Photomicrograph of different area of same section showing tendency to pseudopapillary formations.

SUMMARY OF CLINICAL SIGNS AND SYMPTOMS—20 CASES

	Toxic							Non-toxic													Car ci no ma	Per cent age
Case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Age	35	47	49	37	39	32	45	37	35	42	42	34	25	49	55	25	34	42	62	52		
Sex	F	M	F	F	F	F	F	F	F	F	F	F	M	F	F	F	F	F	F	F		
Cervical thyroid enlargement	-	+	++	+	++	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	85	
Loss of weight	++	++	++	+	+	+	-	-	++	-	-	-	-	-	-	-	-	-	-	+	40	
Toxic symptoms	+	++	+	++	+	++	+	-	-	-	-	-	-	-	-	-	-	-	-	-	35	
Nervousness	-	-	++	+	++	++	++	-	-	-	+	+	+	-	-	+	+	-	-	-	50	
Dyspnea	++	+	-	+	++	-	-	+	+	++	+	+	+	+	+	+	+	+	+	+	85	
"Choking" spells	-	-	+	-	+	-	+	-	-	++	-	-	+	-	-	+	+	-	-	-	35	
Cough	+	+	-	-	-	-	-	++	-	-	-	-	-	+	-	-	+	-	+	+	35	
Stridor	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	+	+	-	+	25	
Cyanosis	-	+	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	+	-	20	
Dysphagia	-	-	-	+	+	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	25	
Venous congestion	+	-	+	-	-	-	-	-	+	-	++	+	-	+	+	-	-	-	+	+	45	

ated by, or disappear after, a thyroidectomy, or the operation may appear not to have been completely successful. In other instances, the toxic manifestations are well in evidence, but are overshadowed by the greater prominence of the mechanical features. The degree of toxicity is, however, usually low, because an intrathoracic goiter is often the seat of various types of degenerative processes and, therefore, does not tend to lend itself well to the development of a functional hyperplasia. But, occasionally, it may be the center of a typical toxic characterization without any coincident enlargement of the thyroid gland, as happened in Case 1 in which the diagnosis of phthisis was made. In the present series of 20 cases, there were 7 patients who were clinically thyrotoxic. In 1 of these, the goiter was completely intrathoracic with no apparent enlargement of the thyroid gland, although subsequent examination of that portion of the gland which was removed along with the goitrous swelling, showed that it was the seat of a coincident hyperplasia. Of the 6 remaining cases, there was slight enlargement in 2, moderate enlargement in 4.

The symptoms appertaining to the toxic state are of that lesser degree of severity which is the general rule with nodular goiters. The signs of toxicity, as evidenced by loss of weight, myasthenia, exophthalmos, thirst and amenorrhea are, as a rule, slight, although loss of weight may be more noticeable in those cases in which difficulty in swallowing is a feature. The symptoms commonly present consist of tachycardia and palpita-

tion, sweats, tremors, increased nervousness, and emotional instability. This group of symptoms we regard as evidence of autonomic overactivity and an accompaniment not necessarily indicative of thyroid overactivity. It was present in some of the non-toxic cases, particularly in those patients who were subject to dyspnea on exertion, or were troubled with the menopause. Exophthalmos was seen in only 1 patient (Case 6) and was moderate in degree. The basal metabolic rate was raised in each of the patients, the average increase being +30, in 1 patient it was over +40.

Pressure effects. The early manifestations of pressure are usually referable to the respiratory system, owing to the close attachment of the swelling to the trachea. Dyspnea on exertion is probably the earliest and most frequent of these symptoms and is due to the diminished respiratory exchange, an effect which is consecutive to the narrowing or flattening of the trachea or to its dislocation from the midline. It may be present for some months or years without having given rise to much disturbance or without getting very much worse. As a rule, however, it progresses steadily *pari passu* with the distortion of the trachea and may ultimately pass into a more or less continuous form of breathlessness. At other times, the process may be more acute and attacks of asthma may be simulated, becoming associated in long standing cases with chronic bronchitis and emphysema. Indeed, this asthmatical simulation is so real that the possibility of intrathoracic goiter should be borne in mind in the diagnosis of

every case of asthma which commences in middle life. Another type of respiratory disturbance, which is not uncommon, but which is also very typical of the disorder is that which is referred to by the patient as a "choking spell." This consists of an attack of acute dyspnea which is always very distressing and may be fatal. It is due to respiratory obstruction and is often precipitated by a twist of the head or similar movement, or on lying down so that the patient after a time learns to avoid those movements, or that position, which experience teaches him are liable to produce an attack. Sometimes, the patient is affected during sleep and may die from suffocation without recovering consciousness. The gouter plongeant, is very apt to be associated with "choking spells" because of likelihood of the swelling to become impacted in the thoracic inlet during one of its periodic excursions. In the present series of 20 cases, there were 17 instances of dyspnea 7 of which were subject to choking spells, and one was an instance of gouter plongeant. Cough is another symptom which, although less frequent, may become very pronounced. It is usually of a dry nature and is due to an inability to expel a small collection of mucus which lodges behind the obstruction. Occasionally it may be the sole symptom for some time as in Case 8 in which a diagnosis of phthisis was made but more often, it is found in association with dyspnea. The combination of dyspnea, cough, and cyanosis may give rise to the view that the patient is suffering with heart disease. Case 14. Cough was a noticeable symptom in 7 patients of present series.

Stridor was noticed in 5 cases and was due apparently to narrowing of the trachea, but it may also be due to a loss of power of the laryngeal abductors. In these cases, the cough would probably take on the hoarse character which is so characteristic of certain aneurisms of the aortic arch. When the narrowing is due to pressure it may be so extreme that the airway becomes almost completely occluded. In 1 case in the present series, it became necessary as a life-saving measure to establish an immediate air passage. This was done by passing a catheter under bronchoscopic vision through the obstruction when it was found that only the smallest size tube available would pass, so that pure oxygen had to be administered while the patient was being prepared for immediate operation. However a minor degree of weakness of the recurrent laryngeal nerve, insufficient to give rise to symptoms, is by no means uncommon. This is really only to be expected as it is found in some 10 to 15 per cent of normally situated goiters, and it is on this

account that many surgeons consider it a good practice to examine the larynx in all patients requiring thyroidectomy. The presence of hoarseness or inspiratory stridor would definitely suggest the possibility of such a complication, but this was not noticed in our cases. The frequency of nerve involvement has been placed as high as 25 per cent (Hilggin, 1927). One instance has been recorded of bilateral recurrent laryngeal nerve palsy.

Next to a disturbance of the respiratory tract, it would appear that the esophagus is the most frequent organ to suffer. Dysphagia occurs about as frequently as cough. It is not severe as a rule, except in those cases in which the goiter infiltrates itself between the trachea and the food tube or more rarely passes behind the latter structure which would then be compressed simultaneously from the front and rear. This complication is seen more commonly in the cervical type of goiter particularly when it is situated upon the left side, but it may also occur with the intrathoracic type. In a case of this sort, the food tube may rarely sustain a sharp kink or bend the clinical and x-ray pictures suggesting the presence of an esophageal diverticulum. Dysphagia may however become a prominent feature when the goiter is complicated by the development of a malignant change.

Pressure on the venous return may also be a marked feature in certain cases. A retardation or definite obstruction to the flow of blood from the upper part of the body is shown by the presence of large veins in the neck and in advanced cases, a marked suffusion of the head and neck. The pressure may be most marked on the superior vena cava, when the goiter is deeply placed, but more often one or other of the innominate veins suffers the most, leading to distention of one or both jugular veins, and in severe cases to cyanosis, and even edema of the face. In most cases, however a mild degree of venous obstruction is always present and is usually quite visible to infra red photography (Fig. 3) although much less so to the naked eye. Other features which may be regarded as clinical rarities occur in the course of an intrathoracic goiter and are the effects of pressure on the thoracic duct, giving rise to chylothorax, inequality of pupillary contraction from disturbed sympathetic innervation, and alteration of the pulse pressure. None of these rare features occurred in any of the present series.

DIAGNOSIS

In most cases this should not be difficult if the possibility of the condition is borne in mind. The frequency of the totally intrathoracic goiter is

very low, and, therefore, all other cases will show a cervical enlargement which should form a clue to the nature of the condition. The development of dyspnea in a woman with a goiter, particularly if associated with a feeling of pressure behind the sternum, is very suggestive, or the onset of acute attacks of shortness of breath with cough, dysphagia or venous congestion of the head and neck is equally characteristic. The points to be noted upon examination are the position of the trachea, whether centrally placed or deviated from the midline, ptosis or fixity of the larynx, inability to palpate the lower pole of the thyroid, a maneuver which should be quite practicable when the head is flexed. Its presence should be suspected in cases of thyrotoxicosis when the thyroid gland is not much enlarged in proportion to the degree of activity suggested by the symptomatology and also in those cases of asthma which develop in middle life or are associated with unusual clinical features. The employment of roentgenology as an aid to diagnosis is almost indispensable for the confirmation of the diagnosis and for the differentiation of conditions, such as Hodgkin's disease, aortic aneurism, thymic enlargement, and other tumors of the upper mediastinum, which are likely to give rise to difficulty in diagnosis.

OPERATIVE TECHNIQUE

As the type of pathological change present in the intrathoracic goiter is not one that lends itself to improvement by x-ray therapy, removal should be advised in every case. The operation presents no great technical difficulty and can be performed under local anesthesia. Those operators who employ this type of anesthesia consider that it avoids the risk of respiratory embarrassment at the time of operation and lessens the chance of postoperative complications of the respiratory tract. It is a debatable point, however, whether this statement is fundamentally sound because, in a bad case, much respiratory embarrassment may already exist and this is often greatly increased by the manipulations due to the operation. In the present series, it was found that the most satisfactory type of anesthesia was obtained by means of an intratracheal tube long enough to pass below the obstruction, the exact position of which could be ascertained by means of the bronchoscope. Apart from ensuring adequate respiratory exchange during the period of anesthesia, this method has the additional advantage in that the tube serves as a guide to the position of the trachea, a point about which it is important to be sure. At the same time, if the sternum should require to be split (this was not necessary

in any of present series), the procedure would occasion no further inconvenience to patient.

The usual type of collar incision was employed in all cases and was found to be sufficient for the purpose. In general, the first step of the operation dealt with the ligation of the main arteries to the gland, because it is known that the intrathoracic portion derives its blood supply from these vessels. It is usually simple enough to ligate the arteries to the upper pole, but the inferior thyroid arteries are often not so accessible, as they may be buried beneath the mass of goitrous enlargement. However, having effected the control of vascular supply as far as was possible, the next step consisted in the resection of the cervical portion of the lobe from which the goiter appeared to originate, so as to enable the inferior thyroid arterial supply to be controlled more effectively. Any connection of tumor with the opposite lobe was also divided before the attempt at enucleating the swelling was made. In this way the main blood supply to the goiter was controlled, but further efforts were made to avoid the possibility of hemorrhage by removing the tumor *in toto* rather than piecemeal, and by taking care to remain within the capsule of the goiter. It was found that in many cases the best way to accomplish this was by the use of the index finger which would be inserted laterally or behind the tumor and worked downward into the thorax. By this means it was possible to reach the lower end in about half the cases, but in the remainder this was not possible and blunt dissection by means of small pledgets of gauze was used instead. In some cases, however, it became necessary to employ traction. The danger in pulling is, of course, the possibility of tearing an artery, so that care must be taken to see that it is carried out as gently as possible and that advantage is taken of any small bands of fascia which may be found to be attached to the goiter. At the same time the danger of rupturing or perforating the softened trachea and the close proximity of the recurrent laryngeal nerve on the left side must be borne in mind. Possibly, in a difficult case, it might be preferable to split the sternum rather than risk removing the goiter in pieces, but, as has been stated, this maneuver was not necessary in the present series, even in connection with the three goiters which were completely intrathoracic. If it should become necessary to split the sternum, the gap in the bone should be wedged so as to secure the maximum benefit from the measure. The control of hemorrhage was effected by means of packing, a method which was particularly effective if employed within the confines of the capsule.

In one of the totally intrathoracic cases, the deep attachments of this layer were clamped off and ligatured as is sometimes done in the removal of a thymic tumor. After the swelling had been removed, the cavity was inspected by means of a good light and all bleeding points were sealed off with the cautery. Drainage was used in all cases for 24 hours, the cigarette type of drain being the most useful.

Postoperative complications. After the control of hemorrhage, the most immediate danger consists of the collapse of the trachea, a complication which is liable to follow any operation for goiter but especially the intrathoracic type on account of the degree of distortion and compression to which the trachea has been subjected. As the area of collapse may arise within the thorax a tracheotomy may not always be effective unless the means to intubate through the tracheal opening are also available. Other possible complications are the occurrence of mediastinitis, tracheal or esophageal fistula, laryngeal nerve palsy and secondary hemorrhage. At the same time a thyroid crisis may supervene if the patient is toxic. There were no deaths in the present series of intrathoracic goiter although there were 10 deaths in the total series of 1365 thyroidectomies.

SUMMARY

1. The suitability of the terms "total and "partial," as at present applied to intrathoracic goiter, is questioned. In present day usage the term "total" is applied to that type of goiter in which the greater portion of the swelling is situated within the thorax, and the term "partial," to that in which the larger portion lies outside the thorax. With this nomenclature it follows that many goiters will be referred to as "total" which, in point of fact, are not strictly so, and others will be referred to as "partial" which are mainly cervical, but which possess a small extension into the thorax. To overcome this difficulty it is suggested that the term "intrathoracic" should be reserved for those goiters in which the whole, or the major portion lies within the thorax and should not be employed to describe those which are mainly cervical in type with a permanent retrosternal extension. This limited application would permit the distinction between "total" or "complete," and "partial" or "incomplete" to be made with fairness and accuracy.

2. In a series of 365 thyroidectomies, there were only 3 instances in which the goiter lay entirely within the thorax, and 17 in which the

major portion of the goiter was intrathoracic. These proportions are equivalent respectively to 0.23 per cent and to 1.34 per cent. There were 91 cases in which some portion of the swelling was permanently retrosternal but as these were cervical in type, their data have been excluded from this article.

3. Of the 20 cases which were thought to be intrathoracic, the operation specimen was examined in all. It was found that the pathological changes did not appear to differ greatly from those which are found in cervical goiters about the same age period. In general, the toxic variety appeared to show, with one exception, only a mild degree of activity and the nodular variety seem to be disposed to show a more advanced degree of those types of degeneration which are not uncommon in that type of goiter.

4. There were 7 cases in the series in which definite manifestations of toxicity were evident. One of these was completely intrathoracic, and 4 others showed only a slight enlargement of the thyroid gland. This proportion, 30 per cent, approximately suggests that the frequency of these toxic cases may be higher than is commonly imagined but that their manifestations are over shadowed by their more prominent mechanical effects. It also permits one to suppose that certain cases of thyrotoxicosis, persistent after a thyroidectomy may be dependent in a small proportion to the presence of an active intrathoracic extension.

5. The most constant feature was dyspnea and the most characteristic, the occurrence of a choking spell. The former was noticed in 85 per cent, and the latter in 35 per cent. Other effects which were dependent mainly upon pressure on the trachea, the esophagus, or the cervical veins, were present in about equal proportions.

6. Treatment was straightforward and did not involve a splitting of the sternum in any of the cases. There were no postoperative complications and the patients did well in all.

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THE TREATMENT OF CARCINOMA OF THE COLON IN SMALL HOSPITALS

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THIS report is submitted for the purpose of analysis and study of cases of carcinoma of the large bowel treated surgically in an open staffed small general hospital and to make a plea for group study and treatment in the hope of improving mortality statistics. The study covers a series of 49 cases of carcinoma of the large bowel, treated over a period of 10 years. It is obvious that this study, when compared with reports from larger clinical centers where colon surgery is under the control of a small specialized group, has no value except disclosure of end-results in such cases when patients are treated in the small hospitals.

The literature concerning surgery of the colon is shockingly barren of studies of this type with a few exceptions P C Morton, W F Gemmel, C Rosser. The writer feels that in the small general hospital there is great and urgent need for improvement in the care offered to the patient with colon cancer. It is only too obvious that he is not getting the same opportunity as is the more well to do patient (or indigent) in the large clinical centers.

Clinical analysis The series of cases analyzed comprised 49 in number, and the patients were treated over a 10 year period by 11 different surgeons. A statistical break-down of this small series discloses nothing that has not been previously reported as regards distribution, age, incidence, and previous symptoms as elicited from the past history. An analysis of the past histories discloses the usual incidence of previous treatment for hemorrhoids and a high percentage of previous abdominal operations.

Surgical management The thoroughness and adherence to detail of the pre operative management appears to have been grossly influenced by the economic restrictions imposed by the cost of hospitalization. The average number of days of pre operative preparation was 43 days. Pre-operative peritoneal vaccination was used in 3 cases. No doubt the delay on the patient's part in seeking surgical aid for carcinoma of the colon has been influenced by economic factors in the same manner in which there has been a 20 per cent increase in surgical delay in appendicitis. This has been pointed out by Kelly.

In the series there were 28 elective operations performed. Eleven patients died within 16 days of operation, a mortality of 38 per cent. Peritonitis, cardiac failure, pulmonary embolism, surgical shock, and pneumonia were stated causes of death, in order of decreasing frequency. Nine were discharged from the hospital. Three were untraceable. One lived 2 years, 1, 14 months, 4, less than 1 year. Generalized metastasis caused the death of 5. Intestinal obstruction is reported as the cause of death of the other traceable cases. At the time of this study, 2 had survived 5 years, 2, 4 years, 2, 3 years, 2, 1 year. At the end of the 3 years, 6 patients were living and well, 35 per cent.

Eight patients were admitted to the hospital with acute intestinal obstruction. Laparotomy was done within 24 hours with a 62.5 per cent mortality, death being caused by peritonitis and obstruction, or peritonitis alone. It is in this latter group, that the writer feels there could be the greatest improvement in pre-operative management, namely, non-surgical decompression maneuvers with the Wangenstein apparatus or the Abbott-Johnson intestinal tube. Particular attention should be directed toward establishing the water balance of these dehydrated people. The situation is seldom sufficiently urgent to preclude the determination of the carbon dioxide combining power of the blood. The chloride level can easily be brought to normal by the administration of $\frac{1}{2}$ gram of sodium chloride per kilogram of body weight for each 100 milligrams that the blood plasma chloride level has been depressed (1). Of the greatest importance is the use of blood transfusions before operation.

In 11 elective operations upon the left colon, 7 different types of surgical procedures were attempted. Thirty-six per cent died within 16 days. In 8 elective operations on the right colon, 6 different types of surgical procedures were carried out with an immediate postoperative mortality of 62.5 per cent. Twelve different types of surgical procedures were done in elective operations on 6 patients with carcinoma of the rectum. Two died within 16 days of operation, a 33.3 per cent mortality. Four died within one year, a 65 per cent mortality.

Six patients with rectal carcinoma were treated by radiotherapy. One patient died of peritonitis following perforation of the rectum by the radium applicator. One died of arteriosclerotic heart disease 16 days after radiation therapy was begun. One is not traceable and the other died within 3 years. The immediate posttherapy mortality was 16 per cent, a probable 100 per cent in 3 years.

In this particular type of hospital, any attempt on the part of the attending surgeon to advocate a group study and a careful pre-operative preparation, is often interpreted by the patient and more frequently by the relatives, as a *loading up maneuver to milk the patient of money*. It is obvious from this conception on the patient's part that the average standard of care in Detroit is reflected and the surgeon's attempt to offer them something better is misinterpreted. Not the least important among the factors retarding solution of this problem is the lack of co-operation and esprit de corps among the staff members.

That the enviable mortality statistics of the larger clinical centers are the direct result of

specialized management is quite evident. One hundred colon resections at the Mayo Clinic were carried out with a mortality of 16.21 per cent (5). Eighty-five colon resections were performed at Peter Bent Brigham Hospital with a mortality of 17.5 per cent (5). No improvement can be expected in the small hospital field until one qualified surgeon who is particularly interested in colon surgery is permitted to treat or at least supervise the treatment of all patients with cancer of the colon who come to the hospital for treatment by the staff. The occasional operator should not be tolerated.

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RESULTS OF TREATMENT IN ACUTE APPENDICITIS

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THE treatment of acute appendicitis is not a closed issue. It is generally agreed that immediate appendectomy is indicated in early non-ruptured acute appendicitis. However, opinion is divided in regard to the question of surgery in the ruptured appendicitis case. Some favor immediate operation in any stage of the disease, while others do not believe in operating when there is diffuse peritonitis.

In order to answer this and other questions, we have studied the results of cases at the University of Nebraska Hospital for the 7 years, 1932 to 1938, inclusive, and from the private practice of one of us (H H D) from 1928 to 1938. At the University Hospital there were 650 cases, 117, or 18 per cent, of which were ruptured when first seen. In the private practice there were 313 cases, of which 62, or 20 per cent, were ruptured when first seen. This made a total of 963 cases of acute appendicitis studied. So called chronic appendicitis and subacute appendicitis were not included in this study.

Acute appendicitis may be classified as follows: (1) non-ruptured, (2) local spreading peritonitis, (3) diffuse peritonitis, (4) abscess, and (5) moribund.

Group 1, non-ruptured. Of the non-ruptured cases there were 252 in private practice and 532 at the University Hospital, totalling 784. The mortality was 2 in each group, or 4 deaths in all, which was a mortality of 0.5 per cent.

GROUP 1 —NON-RUPTURED

	No	Deaths	Per cent
Private	252	2	0.8
University	532	2	0.4
Total	784	4	0.5

If every patient with appendicitis were operated upon before rupture, the mortality of the diagnosable cases would be held down to approximately the figure in this group, 0.5 per cent. Therefore, the campaign both to the public and to the medical profession for early operation should be vigorously continued.

Group 2, Local spreading peritonitis. This group included the early ruptured cases with tenderness confined to the lower right quadrant of the abdomen in which, at time of operation, an exudate was found near the appendix and some-

times in the right lumbar gutter and/or in the pelvis. Most of these patients were in the second day of the attack, a fair number were in the third day, and a few were in the first 24 hours. These patients usually had a temperature of 100 to 102 degrees and had more tenderness and rigidity than the non-ruptured cases. These signs also covered a little larger area but were still confined to the lower right abdomen. These were the early ruptured cases and at times it was difficult before operation to be sure whether the appendix had ruptured or not.

GROUP 2 —LOCAL SPREADING PERITONITIS

	No	Duration	Hospital stay	Temperature	Leucocytes	Deaths	Per cent
Private	34	2	19	100.5	21,500	2	6
University	59	2.2	22	100.8	17,880	3	5.1
Total	93	2.1	21	100.7	18,940	5	5.4

Treatment consisted in appendectomy without drainage in 3, appendectomy with drainage in 79, and drainage only with appendectomy later in 8.

Deaths in private cases were due to secondary hemorrhage in 1 and pulmonary embolus in 1; in the University Hospital cases were due to diffuse peritonitis in 3 instances.

Of the 34 private cases in group 2 there were 2 deaths, but neither was due to peritonitis. One patient whose operation was performed out of town died on the sixteenth day of secondary hemorrhage, and the other on the tenth day of a pulmonary embolus. Of the 59 University cases there were 3 deaths. They were all due to spreading peritonitis.

The most common treatment was appendectomy with drainage. The peritonitis completely disappeared in all but 2 of the surviving cases, each of which developed an abscess that had to be drained.

Group 3, diffuse peritonitis. The most serious cases were those of group 3. Most of these were seen between the third and fifth day of their attacks, although they occasionally arose a day or two before or after this time. The conditions in these cases were much more severe. Commonly the temperatures were 102 to 105 degrees, the leucocytosis averaged 21,000, tenderness and rigidity extended beyond the lower right abdominal quadrant, and the general appearance was typical of peritonitis cases.

The method of treatment in this group is debatable. Some surgeons advise immediate operation while others do not operate until the symptoms clear up entirely later draining the abscess. At the present time probably the majority of surgeons are operating in these cases as soon as possible after they first see them, but there is an increasing number who delay operation at this stage of the disease.

In studying the diffuse peritonitis cases, we have divided them into those with early operation and those with delayed treatment. Up to 1933 it was the practice of one of us (H.H.D.) to operate immediately at this stage. In this group were 11 of whom died, a mortality of 73 per cent. Since then with delayed operation he has had 7 cases with only 1 death, a mortality of only 14 per cent. The patient who died had a questionable diagnosis as there had been a much more acute onset and much more rigidity than was usual for appendicitis. However as autopsy was not done, it seemed only fair to include this case in the statistics. The University group, treated with immediate operation, had 2 deaths in 6 cases, a mortality of 33 per cent. With delayed operation, on the other hand, there was 1 death in 7 cases, a mortality of 14 per cent. Taking both groups together the mortality with immediate operation was 60 per cent, and with delayed operation it was only 14 per cent.

GROUP 3—DIFFUSE PERITONITIS

Immediate Operation

	No.	Deaths	Temperature	Leucocytes	Deaths	Per cent.
Private	11	8	102	54,400	0	3
University	6	2	104	13,500	1	33
Total	17	10	104	71,900	1	60

Delayed Operation

	No.	Deaths	Temperature	Leucocytes	Deaths	Per cent.
Private	7	1	102	56,000	1	14
University	7	1	104	50,500	1	14
Total	14	2	104	56,250	2	14

Of the 10 deaths following immediate operation, all were due to peritonitis, and in at least 3, there were metastatic infections, showing that there had been septicemia.

When we speak of delayed operation in these cases, we do not wish to imply that this improvement of results can be obtained simply by letting the patient alone. The details of management are exceedingly important. The gastro-intestinal tract is given absolute rest and is decompressed

by use of gastric suction. The fluid balance is carefully maintained. We no longer fear giving sedatives as it has been shown that morphine does not increase distention and actually stimulates peristalsis. All of these patients, after recovering from the peritonitis, are sent home with instructions to return in 10 weeks for subsequent appendectomy.

Of these 7 cases with delayed operative treatment, 1 died, 4 developed an abscess that had to be drained, and 2 recovered without residual abscess. However in one of these two, because of too early operative intervention, infection was started up again, and a pelvic abscess developed later. In view of this case and one other in which appendectomy was done a little too early after peritonitis, we definitely advise waiting at least 3 months and preferably 10 to 12 weeks before performing subsequent appendectomy. In only one of these cases was the appendix found sloughed away. In the remaining cases it was a definite menace. Therefore although we recognize that an occasional appendix will be destroyed by the inflammation, it seems best to advise appendectomy in all patients 10 to 12 weeks after the acute attack.

Concurring with the experimental work on peritonitis, these results indicate that delayed operation is the treatment of choice in diffuse peritonitis. It has been thought in the past that, even though the mortality was high, we should operate to give the patient his only chance. We must change our views and realize that "masterful inactivity," as Deaver has expressed it, will save many of these lives. In other words there is a mortality of treatment as well as a mortality due to the disease.

Group 4 abscess. Localized abscess if present usually occurs after the sixth or seventh day of the disease. The cases included in this group for statistics were those in which patients had this condition on admission. In addition there were those of the diffuse peritonitis group which later developed abscess. A pelvic abscess was suspected if, after some improvement, the temperature and leucocytosis rose, a diarrhea developed, and a mass could be felt by abdominal, vaginal, or rectal examination. If the condition grew worse with no discernible abscess, a fluoroscopic examination or x ray plate was made to discern the possibility of a subphrenic abscess. If found in the right posterior area, the usual location in these cases, it was drained by resecting the right twelfth rib and opening the space extraperitoneally at one stage, the procedure which has been described by Alton Ochsner.

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GROUP 4—ABSCESS

	No	Duration	Hospital stay	Temperature	Leucocytes	Deaths	Per cent
Private	8	8	20	100.4	26,000	0	0
University	42	9	23	100.5	18,500	4	9.5
Total	50	9	26	100.5	19,900	4	8

Treatment consisted of appendectomy with drainage in 32 cases with 3 deaths and drainage only in 18 cases with 1 death

Of the 50 cases of abscess studied, there were 4 deaths, all in the University Hospital series. In 3 of these an appendectomy was done as well as drainage. In 2 of these 3, the breaking down of the abscess wall to reach the appendix resulted in spreading the infection and producing a fatal diffuse peritonitis. We advised, therefore, to open the abscess extraperitoneally and not to remove the appendix unless it was easily accessible and the abscess wall was not broken through by the procedure. An abscess at the right lumbar gutter could be approached by a McBurney incision, the mass found before the peritoneum was opened, and then the peritoneum opened where the mass was in contact with it. A pelvic abscess could be drained through the vagina or rectum. If an incision was made and no abscess found, the peritoneum was opened and the abdomen was explored carefully and gently. If an abscess was then found, the incision could be closed and another one made in a location to reach the abscess extraperitoneally.

Group 5 Moribund patients No discussion of the moribund cases is necessary. Four of the 5 cases were at the University Hospital. Needless to say, all of the patients died irrespective of treatment.

SUMMARY CHART

Group		Average duration	Total	Deaths	Per cent
1	Non ruptured	1	1	1	100
2	Local spreading peritonitis	2.1	1	1	100
3	Diffuse peritonitis	4	1	1	100
4	Abscess	6	1	1	100
5	Moribund	12	1	1	100
	Total		5	5	100

SUMMARY AND CONCLUSIONS

- 1 The commonest causes of death in acute appendicitis are purgation and perforation.
- 2 A statistical study is given of 170 cases of peritonitis, secondary to acute appendicitis.
- 3 A patient with a non ruptured acute appendicitis, usually seen in the first day of attack, should have immediate appendectomy.
- 4 The patient with local spreading peritonitis, usually seen on the second day, or on the first or third day, should have immediate appendectomy. Most surgeons also do this.
- 5 In patients with diffuse peritonitis, commonly seen from third to fifth day, mortality was 60 per cent, while in those treated by delayed operation it was only 14 per cent.
- 6 Abscess, which usually takes 6 or more days to form, is best treated by drainage, care being used not to break down the abscess wall and thus produce a diffuse peritonitis.

INFECTED ECTOPIC PREGNANCY

Infected Pelvic Hematocoele

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SUPPURATION complicating ectopic pregnancy has long been recognized as a clinical entity. During the last century this complication seems to have been frequent. With the advent of immediate surgery in ectopic pregnancy, it has become rare; that it has not entirely disappeared is evidenced by the fact that 10 cases of infected pelvic hematocoele have been seen on the wards of a large city hospital and in private practice by the senior author (H. C. F.) within the past 8 years.

In contrast with the rather full discussion found in the older text books, many of the modern books do little more than mention that this complication may occur and advise colpotomy as the treatment of choice. A number of case histories have been published.

Lawson Tait, in 1888 did much to clarify the syndrome of pelvic hematocoele by insisting that it was always secondary to ectopic pregnancy. While definite or presumptive histological evidence of extra-uterine pregnancy is present in only 5 of the 10 cases of infected hematocoele to be reported, it is felt that probably all of them illustrate suppuration occurring in ectopic pregnancy. Inasmuch as the underlying pathology of the two conditions is essentially similar, i.e. infection of encysted blood with or without a fetus, it is believed that until a larger number of cases are observed the two may be conveniently discussed together, particularly from the viewpoint of diagnosis and management.

ETIOLOGY AND PATHOGENESIS

It is not pertinent, at this point, to present a concept of the etiology of ectopic gestation as this has been discussed elsewhere (11). Of interest, however, is the origin and the pathogenesis of the infection. Lawson Tait voiced the opinion of the gynecologists of his era when he stated that almost all cases of suppuration in tubal pregnancies occurred in those which had ruptured into the broad ligament. He described one instance of suppurative intraperitoneal ectopic pregnancy

but believed it to be rare. Berry Hart, in 1893 described two autopsy cases in which vaginal sections apparently confirmed Lawson Tait's view. The explanation advanced was that the gestational sac was closely applied to the rectum without any intervening peritoneum, and therefore, organisms could easily pass from the rectum to the hematoma, thus causing essentially an extra-peritoneal abscess. This view has been carried down in most of the monographs of today, but it is probably an infrequent pathway of infection. Intraligamentary rupture occurs so infrequently (13) that it seems difficult to account for all cases of suppuration in this manner.

Secondary infection from the intestines may produce abscess formation in an intraperitoneal hematocoele. Although this is difficult to prove, the recovery of intestinal flora—colon bacilli, staphylococci in cultures taken from the infected hematocoele is highly suggestive (Cases 3 and 6). Infection with the typhoid and paratyphoid bacillus has been reported (1, 26). Infection by the gonococcus may be responsible (Case 10). Tubal pregnancy usually occurs during the chronic or healed phase of salpingitis—“follicular salpingitis.” However, ectopic pregnancy may occur during a healing salpingitis, although the gonorrheal inflammation has not yet entirely subsided (6).

In Cases 1 and 8 a history of recent uterine interference performed at another institution was obtained. Inasmuch as all uterine cavities are infected following a curettage, and because of the time relationship, it seems fair to assume that the curettage was the unwitting source of infection. Although the history of manipulation was elicited twice, it probably occurred more often. At Harlem Hospital, evidence of attempted abortion is often found in ruptured ectopics. *Intra-uterine manipulation is probably the most important source of infection in a suppurating pelvic hematocoele.* In this series there was no instance of infection secondary to a bacteremia.

SYMPTOMATOLOGY

The symptoms are compatible first with an ectopic pregnancy followed later by signs of sup-

¹These case histories are found in references 2-8, 11, 27-29, 31-33, 37, 38, 39.

uration. A typical case will give a history of amenorrhea with perhaps the early symptoms of pregnancy. Suddenly there is an episode of pain associated with irregular vaginal bleeding. This may be interpreted as being due to an incomplete abortion, and curettage for diagnosis or therapy may be done. Subsequently, the patient complains of pain in the abdomen, feverishness, chills, sweats, and exhibits a septic type of temperature curve.

On examination at this time, the abdomen is distended, tender, and a mass may be palpated. On vaginal examination, uterine bleeding is found, ranging from profuse dark-red blood to brownish spotting. When the uterus can be felt, it is enlarged and soft. A tender mass continuous with that palpated abdominally is felt to one side or behind the uterus. The temperature and pulse are elevated and septic in nature, constitutional symptoms of suppuration exist.

Laboratory findings are essentially those of hemorrhage and infection. Some degree of secondary anemia may exist, the leucocytes and polymorphonuclear neutrophils are increased with a shift to the left. Sedimentation rates are usually rapid. The Aschheim-Zondek test is of little value as fetal death has usually occurred some time prior to infection. Decidual tissue passed *per vaginam* is strong presumptive evidence of extra-uterine pregnancy (Case 2).

In the atypical case there is often no history of amenorrhea, nor of any sudden sharp pain to indicate previous tubal rupture. Frequently, the patient does not distinguish between the pain of the rupture and that of suppuration and describes the pain as being continuous. When the infection occurs almost simultaneously with the formation of hematocele, the history is brief and in one case was less than a month in duration. When suppuration of a secondary abdominal pregnancy occurs, the history is of several months' duration. *Most constant is a history of continued irregular vaginal bleeding.*

The fever is not always septic in nature. However, some elevation of the temperature is always present. Fever, in the presence of ectopic pregnancy is not pathognomonic of infection, as the absorption of blood in non-infected cases may cause a low grade rise in temperature. In some cases, the temperature is high on admission, and over the period of a week, gradually subsides to normal, resembling the temperature curve of an acute salpingitis.

The mass varies considerably in size and consistency. In one patient, it was described as reaching the costal margin. In another, it did not extend beyond the true pelvis. It may be hard,

resembling a parametrial exudate, although it is always unilateral and well defined. It may have the shape and consistency of a tubo-ovarian abscess. Occasionally, there is so much encapsulated fluid as to give the impression of an ovarian cyst. On initial examination, the uterus may not be distinguishable from the mass, but careful examination especially under anesthesia, will show the uterus to be separate. Symptoms of a partial intestinal obstruction may be found, these are usually due to an associated paralytic ileus.

In those instances in which the fetus has grown beyond the fourth month, lipiodol injection of the uterus followed by x-ray will show the fetal skeleton to be definitely outside the uterine cavity (Case 5).

DIFFERENTIAL DIAGNOSIS

As has been indicated, the symptomatology of infected hematocele is varied. However, "one cannot make a diagnosis unless he is aware that the condition exists." There are no pathognomonic signs or symptoms, but the total clinical evidence leads clearly to the diagnosis.

Perhaps the most confusing condition to be differentiated is that of the infected abortion. Both patients give a history of amenorrhea, bleeding, and abdominal pain followed by the development of a pelvic mass. The temperature curves are strikingly similar. However, postabortal parametritis is usually a bilateral infection. Its limits and borders are not well defined to palpation. It involves the rectovaginal septum and produces a "true frozen pelvis." In hematocele, the mass is unilateral and has well defined limits, the uterus on careful examination is distinct from the mass and is not "frozen" in by induration. Usually in a well developed postabortal parametritis, uterine bleeding has stopped, in the infected hematocele, *bleeding persists*. Should an intraligamentary pregnancy suppurate, the differential diagnosis from parametritis would be extremely difficult except with a most typical history.

The physical findings and temperature in an infected pelvic hematocele may resemble those of pyosalpingitis or tubo-ovarian abscess (Case 4). When the history of sudden pain is lacking, the differential diagnosis may be very difficult or even impossible. Any irregular vaginal bleeding should lead to the thought of an extra-uterine gestation.

When a considerable amount of encysted fluid is present, the diagnosis may be confused with an infected ovarian cyst (Case 8). Continued uterine bleeding after curettage, the development of fever, and the sudden onset of a cystic mass should make one suspicious of an infected ectopic

An infected fibromyoma or infected abortion in a fibroid uterus may present diagnostic difficulties, but in cases of infected ectopic pregnancy careful examination under anesthesia will demonstrate the lack of connection between the uterus and the tumor.

In short the symptoms and signs that may arise can and do resemble those of any type of pelvic infection. By keeping the syndrome of infected hematocoele in mind, careful evaluation of the history and physical signs will suggest the proper diagnosis.

TREATMENT

The diagnosis of ectopic pregnancy and its early operation is now carried out in a high proportion of cases. But there will always be a few cases that escape early operation and form a fertile soil for suppuration. Mismanagement of those cases raises the mortality of ectopic pregnancy considerably. Many of these cases are not recognized as infected ectopic pregnancies and death is ascribed to pelvic abscess, sepsis, or peritonitis whereas the mortality of simple ectopic pregnancy is from 1 to 5 per cent, that of infected ectopic pregnancy is 20 to 30 per cent.

Fortunately the hematocoele becomes encapsulated before infection occurs. It is, therefore, necessary to recognize that an infected hematocoele contains virulent organisms in an ideal culture medium, well walled off and that the escape of this pus into the peritoneal cavity may result in a general peritonitis and death. From observation of cases in the non-operative era it is known that these abscesses point most commonly toward the rectum, vagina, and abdominal wall; fistulous discharge of fetal remnants through these organs was common. In cases pointing toward the abdominal wall, the capsule of the encysted fluid becomes merged with the parietal layer of peritoneum so that these abscesses can be opened without entering the free cavity—a circumstance which may have given rise to the mistaken belief that all these infected cases are primarily extraperitoneal in origin. Similarly when the abscess points toward the vagina or the rectum, its wall fuses with the visceral peritoneum overlying these organs. This fusion with the peritoneum is a natural attempt to "wall off" the infected hematocoele and should not be disturbed at operation.

When the abscess bulges into the vagina, colpotomy should be done. This drains the intraperitoneal abscess but does not disrupt the adhesions forming the upper wall and thereby prevents contamination of the general peritoneal cavity. If hemorrhagic pus is found, no further surgery

should be attempted. In two large series reported, of 18 patients treated by colpotomy only 1 died, as compared to 7 deaths in 17 cases operated on transabdominally (13, 21).

Frequently the infected hematocoele, although it can be felt vaginally rises out of the pelvis and points toward the abdominal wall. In this situation drainage is most effectively secured through the abdomen. A true extraperitoneal inguinal approach is not always feasible as is shown by Cases 1 and 7 in which it was attempted without success; subsequent intraperitoneal drainage was necessary. Simple incision and drainage at the point where the infected sac is adherent to the parietal peritoneum and abdominal wall is all that is necessary.

In all of the cases in which intra-abdominal drainage was attempted, adhesions were found between the wall of the infected sac and the peritoneum. In the future should a patient present herself, and no adhesions exist, a two stage operation similar to that practiced for lung or liver abscess will be carried out. I.e. "packing down" to or into the peritoneum and incision into the sac 24 to 48 hours later after adhesions have been created, thereby walling off the general peritoneal cavity from the infected material. This type of treatment is not new. Parry (22) advised stitching the cyst to the abdominal wall in order to shut off the peritoneal cavity.

The objection to simple incision and drainage has been that convalescence is delayed and that the mass does not entirely disappear (10). Convalescence has been prolonged, but in this series there have been no fatalities with incision and drainage and on discharge or shortly thereafter the pelvis were essentially normal. The post-operative recovery although delayed, was less stormy than that following total excision. Should a mass be persistent and cause symptoms, it is possible that subsequent to evacuation of the pus, secondary removal could be safely accomplished.

Total extirpation of the infected hematocoele by entering the free peritoneal cavity can be successfully accomplished, but is dangerous. The contents of the cyst are septic and any spill invites generalized peritonitis. Occasionally the contents of the sac are sterile or so low in virulence, that soiling does not produce fatal peritonitis.

It has been suggested that in those patients who are not too ill, total removal would be made safer if debravescence can be accomplished (9, 10). It is of interest that Hausermann who also suggests waiting until the afebrile stage reports 5 deaths in 9 infected ectopic pregnancies operated on abdominally. However in Case 4 which was

erroneously considered to be pyosalpingitis, and operation deferred until the temperature, sedimentation rate, and white count had reached normal limits, intra-abdominal excision was successful.

At the present time, it appears that complete excision can safely be accomplished in selected cases, yet it is more dangerous, it is contrary to good surgical principles and it has a higher mortality and morbidity rate than does simple incision and drainage.

In this series, there were 10 cases of infected hematocele with 2 deaths, a gross mortality of 20 per cent. Four of these 10 patients were treated by colpotomy with 1 death, a mortality of 25 per cent. This death occurred in a patient who was moribund on admission and in whom autopsy revealed the presence of an already existing widespread peritonitis.

Three patients were subjected to complete or partial excision of the infected mass. One of these patients died, giving a mortality of 33 per cent. It is our impression that if this patient had had an incision and drainage without contamination of the general peritoneal cavity, her life might have been saved. The convalescence in this group was marked by severe postoperative reactions.

Three patients were treated by abdominal incision and drainage at the point of adherence of the infected mass to the abdominal peritoneum, with no deaths. In these 3 cases, an approach through colpotomy was considered dangerous. Recovery was somewhat prolonged and drainage continued over a fairly long period of time. However, on discharge, the pelvis was clean. No secondary operations were necessary.

CASE REPORTS

Infected Ectopic Pregnancies

CASE 1 R H, aged 22 years, nullipara, was admitted to the hospital, complaining of abdominal pains and vaginal hemorrhage of 8 weeks' duration. Last menstrual period was 14 weeks ago. Shortly before admission uterine packing had been used to control the bleeding. The abdomen was distended, but no masses were felt. The uterus was slightly enlarged and anterior, lying on top of the fundus and filling the entire pelvis was a globular mass. Temperature was 102 degrees, white blood cells, 26,000, polymorphonuclears, 84 per cent, sedimentation rate, 18 millimeters in 20 minutes.

With bed rest the mass grew larger and the temperature began to "spike." Extraperitoneal abdominal drainage 3 weeks after admission was unsuccessful. At laparotomy the omentum completely sealed off a hemorrhagic cyst from the general peritoneal cavity. On incision, bloody pus and placental tissue were found. Abdominal drainage was secured. Convalescence was uneventful, and she was discharged on the twenty fourth day.

CASE 2 E B, aged 34 years, nullipara, was admitted to the hospital with a history of spotting for 2 weeks and

lower abdominal pain for 1 week. She had had no skipped periods. The abdomen was distended and tender. Slight brown vaginal discharge was present. Behind the uterus and to its left, there was a firm well defined globular mass. Temperature was 101 degrees, white blood cells, 26,000, polymorphonuclears, 93 per cent, sedimentation rate, 18 millimeters in 35 minutes. Because of a decidual cast passed *per vaginam*, a diagnosis of infected ectopic pregnancy was made. Colpotomy yielded a large amount of bloody pus which on culture showed hemolytic streptococci, staphylococci, and colon bacilli. She was discharged on the thirtieth postoperative day.

CASE 3 E S, aged 25 years, tripara, admitted to the hospital, with vaginal bleeding of 1 month's duration and abdominal pain of 2 weeks' duration. Last menstrual period was 4 months ago. The abdomen was tender, distended, and contained a mass extending to the umbilicus. Vaginal examination showed a bloody discharge, and the pelvis was filled with a large globular mass. Temperature was 102 degrees, white blood cells, 21,000, polymorphonuclears, 82 per cent. X ray examination showed a 4½ month fetus in the right lower quadrant. At laparotomy 3 days after admission a cystic, necrotic mass containing a macerated fetus floating in foul smelling blood was found. Excision was performed and drains were widely placed. Cultures revealed *Bacillus coli*. The patient died on the ninth postoperative day, apparently of peritonitis.

CASE 4 V B, aged 35 years, nullipara, was admitted to the hospital, complaining of dark vaginal bleeding for the past month and sharp abdominal pain for the past 2 weeks. There had been no missed periods. There was marked tenderness and rebound in the right lower quadrant. There was a dirty red vaginal discharge present and a tender globular mass to the right and behind the uterus. Temperature was 104 degrees, white blood cells, 8,000, polymorphonuclears, 80 per cent, sedimentation rate, 18 millimeters in 55 minutes. Diagnosis right tubo-ovarian abscess. Laparotomy was performed 1 month after admission. A round, hemorrhagic mass containing a small amount of pus was removed with considerable difficulty, and vaginal drains were inserted. The pathological report was ectopic pregnancy. The postoperative course was marked by distention and fever. Patient was discharged on the eighteenth postoperative day.

CASE 5 R M, aged 38 years, secundipara, was admitted to the hospital complaining of lower abdominal pain for the past 3 weeks and vaginal bleeding for the past 2 days. There were no skipped periods. There was a firm tender mass extending to the umbilicus. Pelvic examination was not satisfactory, moderate vaginal bleeding was present. X ray examination of the abdomen revealed a macerated fetus about the size of a 6 months' pregnancy, hipoidal injection of the uterus showed the fetus to be in the peritoneal cavity. At operation an ovoid mass containing foul smelling pus and fetal bones, attached to the left tube was found. Excision with drainage was performed. The convalescence was stormy and marked by distention, pulmonary edema, and foul drainage. Patient was discharged on the thirty fourth postoperative day.

Infected Pelvic Hematocoele

CASE 6 C P, aged 34 years, sextipara, was admitted to the hospital, complaining of irregular vaginal bleeding and lower abdominal pain for the past 16 days. Last menstrual period was 5 weeks before admission. A tense cystic mass extended to the umbilicus. Moderate dark red vaginal bleeding was present. The uterus was masked by a large doughy mass which bulged into the cul-de-sac. Temperature was 103 degrees, white blood cells, 25,000, polymorphonuclears, 95 per cent. Colpotomy was immediately

performed, 500 cubic centimeters of foul smelling, chocolate colored fluid containing some pieces of necrotic tissue resembling placenta, was obtained. Bacteria coli as found on culture. The patient died 36 hours later. Autopsy by the medical examiner's office was reported as pelvic abscess, fibrinous peritonitis, and ruptured left tube.

CASE 7 P. B., aged 3 years, octigravida, primipara, was admitted to the hospital, complaining of amenorrhea of months' duration and irregular vaginal bleeding for the past 4 days. For days there had been severe abdominal pain associated with chills and fever. The abdomen was distended and rigid, its examination of an indefinite mass in the left lower quadrant. Slight vaginal bleeding as present. The uterus was pushed forward by tender mass high in the left fornix. Temperature as 3 degrees, pulse blood cells, 6,000 polymorphonuclears, 90 per cent; sedimentation rate, 8 millimeters in 15 minutes. An extraperitoneal drainage attempted, but after admission as unsuccessful. Five days later she was reoperated upon transabdominally and bluish mass adherent to the lower peritoneum was found. One liter of brown, foul smelling fluid as evacuated and drains are inserted. Culture yielded staphylococci. Pathological report as fibrinous peritonitis with possible decidua reaction. Drainage as extremely profuse and the patient was discharged on the forty-third postoperative day.

CASE 8 G. McF. aged 3 years, nullipara, was admitted to the hospital with history of metrorrhagia for the past 6 months. Three weeks before admission dilatation and curettage was performed elsewhere. One week later she noticed swelling of the abdomen, pain, brown vaginal discharge and fever. The abdomen contained large cystic mass with definite fluid area. There as dirty brown vaginal discharge present. A large mass bulged into the anterior fornix and pushed the uterus backward. The temperature as septic, reaching 103 degrees daily. White blood cells numbered 4,000, polymorphonuclears, 70 per cent; sedimentation rate 8 millimeters in 30 minutes. Six days later as incision at the point of adherence of the abdominal mass to the peritoneum was performed and one quart of foul bloody pus as evacuated. Chloroform drains are inserted. Aerobic cultures are sterile. Patient as discharged on the twenty-second postoperative day.

CASE 9 M. S., aged 5 years, nullipara, as admitted to the hospital, complaining of amenorrhea for 5 weeks and lower abdominal pain for weeks. There as history of pelvic inflammatory disease 3 years ago. Uterus was slightly enlarged and there was questionable small soft mass in the left fornix. Laboratory examinations are normal. While under observation as suspected ectopic, the patient left the hospital against advice. She as readmitted 6 days later complaining of pain, bleeding, chills, and fever. The abdomen was tender and rigid, no abnormal vaginal masses could be felt. Temperature was 100 degrees; white blood cells, 10,000; polymorphonuclears, 77 per cent; sedimentation rate 8 millimeters in 8 minutes. A diagnosis of infected abortion was made, and conservative therapy was instituted. Ten days after admission, mass was noted in the left hypochondrium which rapidly enlarged coincidentally with "spiking" of the temperature. Because the mass was discrete from the uterus, the diagnosis was changed to infected hematocoele, and colpotomy was performed. A large amount of foul bloody pus containing pieces of necrotic tissue was obtained. Aerobic cultures were negative. She as discharged on the eighteenth postoperative day.

CASE 10 M. D. aged 3 years, tripara, was admitted to the hospital, complaining of abdominal pain and vaginal bleeding of 2 week duration. Last menstrual period as 3 weeks before admission. The abdomen was tender. The

uterus was anterior and behind it there as discrete tender fluctuant mass. Temperature as 100 degrees; white blood cells, 5,000 polymorphonuclears, 91 per cent. Cervical smear showed gram-negative, intracellular diplococci. Complement fixation test for gonorrhea as positive. The Archibach-Zondek test as negative. Colpotomy as performed, and several ounces of bloody pus as evacuated. Smears of this pus show organisms similar to gonococci. Patient was discharged on the thirteenth postoperative day.

CONCLUSIONS

1. The most common source of suppuration complicating hematocoele is infection subsequent to intra uterine manipulation. Infection may also spread from the rectum and intestines or from a co-existing salpingitis.

2. Pelvic hematocoele which causes sufficient symptoms to require operation is most commonly caused by ectopic pregnancy. However only 50 per cent of the patients presented had histological proof of extra-uterine gestation.

3. The most constant symptom is persistent and irregular vaginal bleeding. Pain, fever history of a skipped period, and a pelvic mass may be present. The laboratory findings are essentially those of infection and hemorrhage.

4. The signs and symptoms resemble those of any type of pelvic infection and the condition is often misdiagnosed as parametritis, pyosalpinx, infected ovarian cyst, etc.

5. The blood usually becomes encysted before infection takes place. Subsequently there is a fusion of the wall of the mass with the adjacent layer of visceral or parietal peritoneum, a circumstance which has given rise to the mistaken belief that infected hematocoele is primarily extra-peritoneal in nature.

6. When feasible posterior colpotomy is the treatment of choice.

7. When the infected mass must be operated on transabdominally simple incision and drainage at the site of adherence to the parietal peritoneum is safer and preferable to complete excision, except in selected cases.

8. Infection of pelvic hematocoele causes a marked increase in the mortality rate of ectopic gestation. Many cases are not recognized and death is ascribed to pelvic abscess, sepsis, or peritonitis. In this series of 10 cases, there were 2 deaths, a gross mortality of 20 per cent.

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EDITORIALS

SURGERY Gynecology and Obstetrics

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VARICOSE VEINS

IN the normal venous system of the lower extremity the direction of blood flow is always from the superficial to the deep system and never from the deep to the superficial. In varicose veins there exists what is usually appreciated even by the patient as dilatation of the veins or ectasia. Among other changes is one frequently not appreciated, but far more important namely a flow of blood from the deep to the superficial venous system. This of course is an abnormal backflow. In incipient varicosities retrograde flow cannot always be demonstrated. It may be present and not demonstrable even though ectatic veins are easily seen. Sooner or later however in every case that progresses this backflow can be found unquestionably. The retrograde flow may exist only through the saphenous, a most favorable type of case to treat. However as also may be demonstrated by tests, the backflow of blood from the deep to the superficial system may occur at various levels of the leg.

In attempting to treat varicose veins an evaluation of the circulation of the extremity both from the standpoint of arterial blood supply and of venous circulation is most important. More harm than good would result from intentional obstruction of the superficial venous circulation when the capacity of the deep veins is already compromised by a previous thrombophlebitis. For that reason it is important to know whether the deep venous system is obstructed. It is also important to know whether there are varicosities with ectasia alone and no demonstrable backflow of blood in the saphenous or whether there are leaks from the deep to the superficial venous system, either only through the saphenous or in addition through what are presumed to be communicating channels between the superficial and deep systems. The comparative tourniquet¹ test will demonstrate the level of leaks from the deep to the superficial venous system. Previously it was presumed that in most cases showing a retrograde flow below the main opening of the saphenous such backflow occurred through communicating channels in the calf and not in the thigh. By use of the comparative tourniquet test it has been demonstrated that when valves of the communicating veins are incompetent it is generally the communicating veins only of the thigh which are involved and not veins communicating between the deep and superficial systems in the leg below the knee. This is fortunate for when abnormal communications exist between the deep and superficial systems below the knee the case falls into a group which is most difficult to treat.

Mahomet H. R. and Oschner, A. A new test for evaluating circulation in the venous system of the leg or extremity affected by varicosities. *Arch. Surg.* 56, 11, 679.

The problem of the treatment of varicose veins continues to evade complete solution. It is surprising how many methods employed today were used even before the advent of antiseptic surgery. Ligations were done by Paré, excision, at least a crude form of it, was described by Galen and Celsus. The injection of sclerosing solutions dates back to 1856. Infections and inadequate appreciation of the disturbed physiology in applying the methods in the pre-antiseptic era resulted too frequently in failures and unsatisfactory results. However, further accumulation of knowledge and more intense experience have resulted in an evolution of treatment to the status whereby an optimum result is obtained and a minimum rate of recurrence is to be expected. In the decade 1920 to 1930 following the advent of newly described safe sclerosing solutions, the injection therapy for varicose veins was widely used and approvingly and intensely acclaimed. At the beginning of the present decade, reports of series with a high percentage of unsatisfactory results from sclerosing therapy alone when observed over a period of several years, including cases in which an end point in treatment could not be reached, and together with announcements by a number of authors of more satisfactory results following ligation and transection of the vein with simultaneous injection of a sclerosing solution, brought about an entirely new trend in the management of these cases. Only in the last two decades has it been fully realized that not the vein itself, but the abnormally high pressure existing therein, is largely responsible for the symptoms and complications of varicosities. This slowly impressed the necessity of utilizing the best permanent mechanical means of alleviating the abnormal increase in pressure. The best permanent mechanical measure appears today to be transection and ligation of the vein to prevent the retrograde flow and to

interrupt the height of the column of fluid, together with the injection of sclerosing solution. The simultaneous ligation and injection of sclerosing solution has been shown in large series to be relatively safe though not entirely free of danger. It is safe enough to justify its use, in those cases in which a Brodie-Trendelenburg reaction shows that the valves of the saphenous system are incompetent. It is only by the relief of this backflow and back pressure, by ligating and sectioning the vein, and by reducing the lumen of the vein by the use of a sclerosing solution, that good immediate and permanent results can be expected in a high percentage of cases.

No matter what method of therapy is used for varicose veins, one cannot expect to cure entirely the tendency of the patient to develop varicosities. Thus recurrence will probably ensue under best therapeutic management in approximately 15 per cent of the cases. On the other hand, even though recurrences come there has been some relief in the interval and usually the recurrences are less severe. If patients never entirely neglect varicose veins something further can always be done to prevent the occurrence of complications, such as, pigmentation, induration, dermatitis, and ulceration, which inflict such restrictions and suffering on the patient. It has never been definitely proved whether the ectasia or dilatation of the veins begins in the periphery, that is, in the veins of the calf, or in the intracutaneous veins, and progresses centrally or whether there is a primary dilatation at the site of the valves with incompetence, increased pressure, and resulting ectasia in the more distal radicles. Thus, the pathogenesis of varicosities is not accurately known. For this reason one cannot expect to cure the disease entirely by correcting the abnormal physiology through relief of the back pressure by ligation and section of the saphenous vein. Recurrence

or persistence of varicose veins may not always be attributable to varicosities or to the tendency to form them. Improper application of the principles involved in surgery for varicosities undoubtedly is a factor in many recurrences. Ligations below incompetent collateral channels permit the re-establishment of a saphenous vein with scarcely less vicious back flow than previously existed. Thus veins must be ligated at such levels that maximum interruption of retrograde flow and minimum tendency to re-establish channels results.

Much can be accomplished and is being accomplished for cure of varicose veins. Improvements in therapy are still being made and appreciated. The progress of the disease is at least in some individuals self limiting and in these surgical measures can correct to a very satisfactory extent the damage already done. Surgical measures, however, cannot stay the progress of the disease in some patients, i.e., surgery cannot remove entirely the tendency to form new varicosities. The greatest advance of course would come with a solution of the cause and a method of alleviating it. That would be the most certain insurance against recurrence.

HOWARD MAHONEY.

A PLEA FOR RESPECT FOR THE TISSUES OF THE CENTRAL NERVOUS SYSTEM

UNTIL the turn of this century the surgery of the central nervous system was to all intents and purposes, a closed book. Then largely through the brilliance and stimulation of the lately mourned Harvey Cushing, it began a period of what almost may be described as one of riotous expansion. Nothing is now too difficult to attack and technical limitations are very nearly defined by the question as to whether an area to be invaded or excised en

route to disease, is essential to life. Diagnostic methods have kept apace chiefly in conjunction with the x ray and chemical therapeutics like the use of alcohol, has assumed great boldness.

But perhaps this record of achievement is a little marred by an accompanying contempt or indifference toward the brain and spinal cord which it may have bred in the minds of some of the profession. One detects at times a lack of appreciation of the fact that these structures are supplied an individual in full complement to start with, and that not only cannot one single damaged cell be replaced but even healing beneficent elsewhere is noxious here. Healing by scar to close a gap in bone or skin or muscle is a saving property. The same process in a viscus or a gland is of no moment because there is essential cellular tissue to spare in these organs. But in the brain or spinal cord scar from injury or inflammation, can only interfere with blood supply and function of contiguous normal territory.

To be specific Lipiodol is a substance of great value. It is radio-opaque and its use in certain rather rare instances may supply needed critical information. The recent emphasis upon the relative commonness of protrusion of the intervertebral disc, however, has taken it away from its exclusive use by neurosurgeons and has led to indiscriminate utilization in many sporadic cases in which it is not indicated and indeed is harmful. Anyone who has had perforce to dig about in the soggy mess which is the cauda equina of some unfortunate in whom five or ten cubic centimeters of lipiodol has been

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it Happily, myelography with air, is rapidly replacing the use of lipiodol in this large group of cases

During the 1930's the use of alcohol in the always difficult problem of the control of pain has come into prominence Dogliotti's daring suggestion that absolute alcohol be placed in the thecal sac itself for painful affections of the pelvis and lower extremities has frequently had such spectacular results that some have imagined the procedure to be a panacea, unattended by risk As a matter of fact, the judgment of what, if anything, is to be done for the multitudinous types and sites of pain calls for the greatest exercise of experience and neuro-anatomical knowledge Certainly, to elect to inject a substance like alcohol directly into the spinal fluid, with the attendant risk to conus, cauda, and arachnoid, should be regarded as a major clinical decision One wonders what will happen to these structures in ensuing years, when the inevitable fibrosis initiated by incautious or unwarranted injections progresses

Even the neurologists and neurosurgeons, whose creed it is to guard the sacred character of nervous tissue, seem at times to be carried away in the intoxication of an operative *tour de force* One hears them glibly remarking

that the first step in removing an acoustic neuroma is to amputate a good share of cerebellar hemisphere—routinely and without even considering in a given case the possibility of a more conservative exposure, or that expediency in the approach to a hemispheric or ventricular lesion automatically entails the discard of a quantity of normal brain tissue Apparently annoyed by all which gets in their path, they excise it and thereby bring the whole problem to a conclusion

And finally, the psychiatrists, supposedly concerned with the highest intricacies of human behavior, do not stop with the induction of the most terrific of convulsions, but actually to be found among them, are those who advocate, for ordinary periodic mental depression, the empiric mutilation and destruction of cerebral tissue hither and yon in the frontal lobes

In all this enthusiasm, it is well not to lose sight of the inexorable law that there is no regeneration of the tissues of the central nervous system In any procedure undertaken involving it, the axiom should be that the chances of benefit must preponderantly outweigh the harm of injury When in doubt—don't risk it! ERIC OLDBERG



ACROSS THE EDITORIAL DESK

SINCE the beginning of SURGERY GYNÆCOLOGY AND OBSTETRICS thirty five years ago, it has been the policy of the Editors to look upon the Journal as a forum wherein men in practice could express the results of their clinical or experimental investigations.

Many times the Editors have been in disagreement with the conclusions expressed and, now and then with the methods used to investigate the problem under consideration. However honesty of purpose, frankness in the expression of methods used and the results obtained, and a philosophy often expressed by Kanavel ("you may not agree with him, but don't forget there may be something in 't'") have been some of the principles upon which manuscripts have been chosen for publication. We believe that our readers are able to form their own opinions about an operative method or a conclusion reached from a study of clinical cases, and if they disagree violently enough perhaps another piece of work will be stimulated.

MANY comments have reached the author and the Editors concerning the interesting method of presentation used by JOHNSON of Toronto, in his paper entitled, "The Treatment of Uterine Prolapse." The text material, if you recall, was brief but the legends accompanying the numerous line drawing illustrations were full and consisted of just about what the author would tell you if you were watching over his shoulder as he performed the operation. Well made drawings or photographs tell a story in a way that sentences, no matter how well written, may fail to do. It has been our belief for a long time that most of the manuscripts published are far too long and verbose, just as most presentations before medical societies consume too much time. The method, materials used, and the important results of a research problem can usually be presented in ten or fifteen minutes at the most.

THERE is a great deal to be said for the statement that medical papers are written according to an outline that they are often dull when they could be made interesting and that doctors

as a group demand good writing in the fiction they read but spend little time or thought upon their own literary efforts. The time is coming when we shall see textbooks of medicine written to interest the reader whether he be student or practitioner in the story of the disease. Bald descriptions divided into compartments, which are labelled "Etiology," "Pathology," "Diagnosis," "Prognosis," "Treatment," and in which inaccurate statements pass from one book to another and from year to year are rapidly becoming passé.

Each of us is likely to believe that writing for the other fellow whom we believe does it well, is an easy matter: that he sits down and dashes off a well rounded phrase or sentence with the greatest of ease. So many writers, not doctors, have entered strong denials that it seems true to bring the matter up again. However we recently have seen a letter from Harvey Cushing to a colleague of his of many years standing, in answer to a letter complimenting him upon his facility for saying a thing well on paper and asking him to tell just how it could be acquired. With the permission of the doctor to whom the answer was sent we are quoting the letter below:

But my dear man, there is no secret whatever about writing. It is laborious task I best.

"I have no tricks of the trade that I can hand on to you. In fact, there are no tricks to hand on to anyone. My own method is probably the most laborious imaginable. I always write everything out, long hand. My secretary who can read my abominable writing almost better than I can myself then copies it in three spaces so that I can write between the lines. She then copies it again. It's gross and I proceed to knock out unnecessary words and change it around so that it is unrecognizable. Then she, with more grossness, copies it a third time and this process goes on until both of us are heartily sick of it. I would hate to say how many drafts we have had of every chapter in the magnificent book, some fragments certainly twenty years old.

"So far as I can see, no one writes easily. Those who appear to do so are the ones who have spent the most *Galatée* and *Thérèse* in the process. People who undertake to dictate their ideas or still, once, to talk them into dictaphone are likely to find it poor stuff. I once did this myself and then listened in it's such chagrin that I never attempted to do so again.

"With much power to your pen and elbow I am

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN the treatise, *Physiology of the Uterus*,¹ containing 450 pages, of which 132 are devoted to a bibliography with 1,190 references, Reynolds has compiled a comprehensive review of the literature pertaining to the physiology of the uterus with an attempt to correlate the facts adduced therefrom.

The book represents a tremendous amount of work on the part of the author, but its chief value is to be found in the references it contains rather than in the abstracted material, since the original treatise on the various phases of this subject would be more desirable to the interested student. The author is represented in the bibliography by 30 contributions to the literature on this subject.

CHESTER C. DOHERTY

THE new text on phonocardiography entitled, *Heart-Sounds in Normal and Pathological Conditions*,² written by two well known South American investigators, suitably presents the results of their extensive studies. The translation does not detract from the original exposition.

The subject matter is well covered including historical information, methods, normal findings, as well as a wide diversification of pathological states. These include the valvular lesions, gallop rhythm, A-V block, bundle branch block, pulsus alternans, extrasystoles, and auricular fibrillation. The bibliography is extensive with both author and subject indices. The illustrations are well selected and clear in detail.

One is left with the impression that the method is valuable for further investigation of many points of abnormal cardiac physiology, however, one is also inclined to doubt whether the registration of abnormal heart sounds is practical for present day office and hospital practice. For those who are interested in the registration of heart sounds, this book is a worthwhile text. CHAUNCEY C. MAHER.

A TEXTBOOK which can be especially recommended to any student or postgraduate in otolaryngology is *Diseases of the Nose and Throat*,³ by Charles J. Imperatori and Herman J. Burman, and it would be of great value to the practicing physician as well.

The authors answer many questions helpful to the postgraduate by presenting an up-to-date outline.

¹PHYSIOLOGY OF THE UTERUS, WITH CLINICAL CORRELATIONS. By Samuel R. M. Reynolds. M.A. Ph.D. New York and London: Paul B. Hoeber Inc. 1939.

²OXFORD MEDICAL PUBLICATIONS. THE HEART SOUNDS IN NORMAL AND PATHOLOGICAL CONDITIONS. By Oscar Orlas, M.D. and Eduardo Braun Menéndez, M.D. London, New York, and Toronto: Oxford University Press 1939.

³DISEASES OF THE NOSE AND THROAT. By Charles J. Imperatori, M.D., F.A.C.S. and Herman J. Burman, M.D., F.A.C.S. 2d ed. Philadelphia: London, and Montreal: J. B. Lippincott Co., 1939.

which covers the subject completely and in a manner quickly comprehended. The first chapters relate to the necessary equipment for the office of an otolaryngologist. They also stress the value of a meticulous routine examination with the proper technique of treatment. This is all placed before the reader in a most comprehensive manner through the excellent illustrations which picture the operative procedures on the nose and throat as well as the various diseases.

The pathology is well covered and the symptoms, diagnosis, treatment, and causation are well arranged. The anatomy, physiology, and development of the nose and throat have not been neglected and are discussed in the same understanding manner.

Relative to diseases of the sinuses, complications such as orbital infections, which occur in conjunction with sinusitis, are fully explained as is also the importance of sinusitis acting as a focus of infection and causing manifestations of general systemic diseases. Indications, contra-indications, interpretation, and technique of endoscopy in the branch of laryngology are revised and described in detail.

Included also are articles of more recent development and consideration in relation to the nose and throat, such as physical therapy, diseases of the oral cavity, acute laryngotracheobronchitis, and asthma.

GEORGE F. MCINTYRE

THE excellent book, *Positioning in Radiography*,⁴ is the most complete treatise on the subject ever published. Positioning is one of the most important features of any roentgenographic examination. The author has succeeded in illustrating correct positioning in a unique manner by photographing living models. Roentgenograms resulting from such positions are reproduced in the negative phase. The positions are described in a concise and practical manner, and the correct positioning for the examination of every part of the body has been covered. Adequate exposure data are given for each examination. Line drawings and photographs of dried bones are frequently used for illustrative purposes. The book does not include a discussion of electrical equipment or roentgenographic interpretation.

Some of the more recent advances in roentgenographic technique such as kymography, tomography, and cineradiography are discussed. The grade of paper, printing, and illustrations are excellent. The author and publisher are to be congratulated for presenting this superior volume. It will undoubtedly receive a warm welcome both from roentgenologists and from physicians and surgeons generally.

EARL E. BARTH

⁴POSITIONING IN RADIOGRAPHY. By K. C. Clark, F.S.R. St. Louis: The C. V. Mosby Co. 1939.

In the fourth edition of the volume, *A Descriptive Atlas of Radiographs*, the author has rewritten much of the subject matter and has added considerable material particularly to the section on the respiratory system. The chapter dealing with the history of radiodiagnosis has been brought up to date.

The purpose of the book is "to show the immense possibilities of x rays. An attempt has been made to portray the normal and abnormal conditions, rather than the rarities, which are encountered in practice. The reproductions all of them in the positive are often accompanied by line tracings with adequate legends and often a concise clinical note.

The volume is somewhat larger than the previous edition and contains 33 additional illustrations. The book is primarily intended for the use of the clinician who desires to know what aid roentgenographic examinations can give him in making an accurate diagnosis. Radiologists, however as well as clinicians should find this volume useful in their practice.

EARL E. BURT.

THE book entitled *Gynecology* by Herbert H. Schlink, is designed for senior medical students. It reviews a gynecology as a group of lectures would. The chapter on anatomy is sound and well presented. The discussion of symptoms of gynecological disease is useful and well done. Physiology and endocrinology are fairly well presented yet there is a lack of full appreciation of endocrinology and of the value of hormones as therapeutic agents. Dr. Schlink obviously does not have faith in their use except in the menopause. The sections on infections and inflammations are instructive and clear. Malignant disease is covered carefully but not too fully. The chapter on operative gynecology is not satisfactory for a gynecologist or surgeon but should be for the student.

The Schlink eviscerator as a method of closing the cervix seems heavy and complicated. Condemnation of all suspension operations except the Alexander and the Gillman is not generally accepted and is evidence that Dr. Schlink is presenting his own opinions. All will not agree with him. The chapter on postoperative care does not mention the use of the Levin tube or of Wangensteen's excellent work on intestinal obstruction. Some of the postoperative care advocated is ill-considered, such as using a trocar in the areas to remove the septic fluid in an obstructed intestine. The chapters of the book dealing with anatomy, physiology, symptoms, infections, etc., are very good but the treatment and postoperative care could be improved upon.

The book itself is excellent, good paper, good type, and very good reproductions have been used. It can be recommended to students and to general practitioners but not to operating gynecologists and surgeons.

JOE V. MILES.

A DESCRIPTIVE ATLAS OF RADIOGRAPHS. AND A MODERN CLINICAL MEDICINE. BY A. P. BERTWORTH, M.B., CH.B., F.R.C.S. (L.S.) 4th ed. rev. and ed. St. Louis: The C. Mosby Co. 1938. 1000 pp. \$10.00. GYNECOLOGY. By Herbert H. Schlink, M.D. (Syracuse), F.R.C.S. Sydney and London: Angus & Robertson, Ltd. 1939.

THE treatise of 346 pages entitled *Cancer of the Colon and Rectum* by Fred W. Rankin and A. Stephens Graham not only represents the results of the extensive experience of the authors but also utilizes the experiences of other men of prominence in the field of cancer of the colon and rectum. There is no one whose interest and experience in this field of surgery better fits him for such a task than that of the senior author.

The book is divided into 3 main sections. Part I is headed "General Considerations." In this is to be found an excellent description of the anatomy and physiology of the large bowel, with particular attention to the practical aspects of the blood supply and lymph drainage. Incidence, pathology, symptoms, and differential diagnosis are included in this section. Part II is given over to treatment. In this section are discussed the factors influencing the operability and prognosis of the different lesions, the hospital mortality and end-results, and the indications for the various types of operation for lesions situated in the different segments of the bowel and the varying degrees of obstruction. There is also a concise but conservative and well-written chapter by Dr. Fred M. Hodges on the rôle of radiotherapy as well as a complete discussion of the pre-operative and post-operative management of these patients as carried out by Dr. Rankin and Dr. Graham. The final section, Part III, is devoted to a discussion of the various technical procedures which are more generally recognized in the management of the conditions under discussion.

The book is well illustrated. The diagrams are for the most part simple, black and white sketches, easily interpreted, which illustrate well the various technical points.

In spite of the splendid general plan of presentation and the clear wording of the text, there is too much repetition which is particularly trying to the person reading the treatise in continuity. It is disappointing that the excellent work of David and Gilchrist on the lymphatics in relation to cancer of the rectum has not been included in this monograph. It is also to be regretted that procedure which has received so much popular acclaim as DeVries's defunctioning operation should not be described in such work and it would seem to the reviewer that the time and space given to the treatment of such conditions as ulcerative colitis, megacolon, and tuberculous of the colon have no place in a book which the introduction states is specifically on cancer of the colon and rectum.

We must on the other hand, sincerely commend the authors for their definite and clear-cut position in favor of radical procedure for carcinoma of any segment of the bowel, and for their insistence that permanent colostomy is still the backbone of an adequate operation for cancer of the rectum.

CANCER OF THE COLON AND RECTUM. ITS DIAGNOSIS AND TREATMENT. BY Fred W. Rankin, A.M., M.D., F.R.C.S. (L.S.) and A. Stephens Graham, M.D. (in Surgery), F.R.C.S. (Specially) and B.S. (Surgery). Charles C. Thomas, 1938.

REVIEWS OF NEW BOOKS

Let the reader of this review not be misled by the criticisms here given. It is probably the most comprehensive and complete treatise on cancer of the large bowel available today and will serve as an excellent guide or reference book to any surgeon regardless of his experience.

LELAND S. MCKITTRICK.

THE eighth edition of the *Textbook of Bacteriology*,¹ by Hans Zinsser and Stanhope Bayne-Jones, has been thoroughly revised and brought up to date, and this book that characterized the former editions has the same high degree of excellence is maintained in the latest important work and discoveries in bacteriology and immunology are included in this edition together with a fair evaluation and critical discussion of each. In all their discussions the authors are conservative, but when the evidence seems to warrant it, they have not hesitated to express an opinion. On the theoretical and controversial subjects they have presented all the evidence and arguments and have fairly but critically discussed them.

The material has been well selected, digested, and arranged to give the student a broad knowledge of the fundamentals of bacteriology and immunology and at the same time point out the practical application of these sciences to medicine and sanitation.

As a textbook for medical students it serves its purpose well, but it might be more helpful if greater emphasis were placed on diagnosis. If the information through the text concerning the laboratory diagnosis of an infectious disease were brought together and briefly stated under that heading, it would, we believe, be a definite aid to the student. The chapter on pathogenic protozoa has been omitted. The authors, we think, were wise in so doing. Protozoology has grown to the proportion of a separate science and there is no good reason why it should be included in a textbook of bacteriology. The book is somewhat reduced in size but without injuring its value in the least. It is one of the good textbooks of medical bacteriology.

A. W. WALKER

THE short monograph by Leclerc and Moreau entitled *Les Moignons Dououreux*² concerning the nature and choice of treatment of painful amputation stumps is a plea for surgical relief from the constant agonizing distress found in approximately 10 per cent of all patients with amputated extremities. Such painful stumps are frequently the results of accidents of occupation and everyday life, therefore, an effort should be made to obtain relief for the patient both from the standpoint of comfort and that of rehabilitation.

¹A TEXTBOOK OF BACTERIOLOGY THE APPLICATION OF BACTERIOLOGY AND IMMUNOLOGY TO THE ETIOLOGY, DIAGNOSIS, SPECIFIC THERAPY AND PREVENTION OF INFECTIOUS DISEASES FOR STUDENTS AND PRACTITIONERS OF MEDICINE AND PUBLIC HEALTH. By Hans Zinsser, M.D. and Stanhope Bayne-Jones, M.D. 8th rev. ed. New York and London: D. Appleton Century Co., Inc. 1939.

²LES MOIGNONS DOULOUREUX. By Frédéric P. Leclerc and Pierre Moreau. Paris: Louis Arnette 1939.

The experience of the authors is based on 12 patients, 8 of whom were treated surgically with promising results. They divide painful stumps into 2 main classes: (1) the "spinal" type, in which the patient suffers intense, well localized, paroxysmal pain in a definite anatomical distribution, frequently in a phantom limb, with or without local stimulation or irritation of the neuroma, and (2) the "sympathetic" or autonomic type, in which the pain is less acute, but more constant and perhaps more distressing, with all sorts of itching, prickling, burning, and other forms of exhausting painful paresthesias, caused either by local stimulation or by changes in temperature, humidity, vascularity, emotional stress, and various other factors. Actually, however, the authors concede that by far the greater number of cases are a mixture of these 2 primary types.

Various forms of treatment are considered, including dissection and removal of the nerve ends, section of or phenol injection of the nerve trunk with immediate suture of the affected nerve trunk with immediate sympathectomy of the sectioned ends, periarterial sympathectomy, novocain infiltration vessels leading to the affected stump, novocain infiltrations into the nerve and neuroma, novocain infiltration of the upper thoracic chain ganglia, lumbar sympathectomy, stellectomy, cordotomy, and section of the nerve with immediate suture. No cut and dried rule can be formulated in the selection of the type of treatment for any particular case. Section of the nerve with immediate suture is frequently effective in the "spinal" type. Removal of the appropriate ganglia and chain is usually advisable in the "sympathetic" type and a combined operation is likely to be most effective for the mixed type of pain. Operative indications may be arrived at most often by preliminary novocain infiltration of the corresponding sympathetic ganglia.

JOHN MARTIN

A SUCCINCT, adequate, well documented review of present knowledge concerning tuberculosis is the work entitled *Pulmonary Tuberculosis Pathology, Diagnosis, Management and Prevention*,³ by George G. Kayne, Walter Pagel, and Laurence O'Shaughnessy. I know of no better book on the subject in the English language. It is one of the few written by the younger and modern generation of phthisiologists, men who have grown up in the atmosphere of the newer knowledge of the pathogenesis, diagnosis, and treatment of the disease.

It is significant that the author of the excellent sections on pathogenesis is an expatriate German, and that the chapters on surgery were written by an Englishman who secured his training from Sauerbruch. The German influence is obvious and certainly accounts for many of the book's good points and probably for its necessarily bad ones.

Although Germans have made very few of the important discoveries in the field of tuberculosis,

³OXFORD MEDICAL PUBLICATIONS. PULMONARY TUBERCULOSIS PATHOLOGY, DIAGNOSIS, MANAGEMENT AND PREVENTION. By George Gregory Kayne, M.D., M.R.C.P., D.P.H., Walter Pagel, M.D., and Laurence O'Shaughnessy, M.D., F.R.C.S. London, New York, and Toronto: Oxford University Press 1939.

they have been quick to take up new ideas and are thorough in their development and popularization. This has been a great service and it has been performed so successfully that the names of German followers have often become greater than those of the original observers. Thus Ghon has given his name to the discovery made by Parrot and Kuss. Bard's tiny book on chronic hematogenous tuberculosis has been overshadowed by the greater volumes of Neumann. The early infiltrate first recognized by Weisler, Jckes, and Beaucon has been taken over pretty thoroughly by Asmann and Raedeler and in collapse therapy the names of Brauer and Sauerbruch are almost greater than those of Carson, Forlanini, and Murphy.

Because of this prolific scholarship and clinical investigation, Germany, prior to 1934, was the center of discussion of theories of tuberculosis and was the source from which they were distributed throughout the world. If there was a defect in this work, it was in the direction of overtheorization and in a tendency to decide upon matters on which final judgment was impossible.

I do not mean that this book is overly dogmatic. I do mean that the authors are conversant with the

many conflicting theories concerning all phases of tuberculosis. In any work on so uncertain and controversial a subject, the experienced reader will encounter many statements with which he disagrees. Emphasis should be put upon the fact that many investigators attribute to exogenous reinfection greater rôle than does Pagel. The thoracoplasty described in the book is the old Wilms-Sauerbruch paravertebral operation performed in 1 or 2 stages. Although more recent modifications of the procedure are mentioned and described, the impression is given that the older operation is still the standard. This certainly is not the present attitude of the majority of phthisiologists and thoracic surgeons throughout the world. The Wilms-Sauerbruch operation produced not more than 40 per cent of cures. In many hands the more extensive modern operations have increased this incidence to 80 per cent. These are minor criticisms and do not detract from the excellence of the whole book. The surgical section of the book would be found more enjoyable were one not again confronted with the old Sauerbruch illustrations with which he has been familiar for the past 5 years.

JEROME R. HEAD.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

INDUSTRIAL HYGIENE. By Various Authors. Edited by A. J. Latta, M.D. and Jacob A. Goldberg, M.A., Ph.D. New York, London, and Toronto: Oxford University Press, 1930.

TRANSACTIONS OF THE SIXTIETH MEETING OF THE AMERICAN SURGICAL ASSOCIATION. Held at the Homestead, Hot Springs, V., May 4, 5, 1930. Vol. 57. Edited by Walter Estell Lee, M.D. Philadelphia: J. B. Lippincott Co., 1930.

GRUNDLAGEN DER SCHWANGERSCHAFTSKRANKHEITEN FÜR THEORETISCHE RECHTLICHEN UND VORBEREITUNG FÜR KLINISCHE DIAGNOSTISCHE GEBURTSHILFLEHRUNG DER SCHWANGERSCHAFT. By Dr. med. habil. G. Gächter. Dresden and Leipzig: Theodor Steinkopff, 1930.

ETIOLOGIA DA FEBRE ECTOPICA. By Frederico Carlos Gomes. Porto Alegre, Brasil: Livreria Do Globo, 1930.

AN INTRODUCTION TO GASTRO-ENTEROLOGY. Being the Third Edition of *The Mechanics of the Digestive Tract*. By Walter C. Alvarez, M.D. New York and London: Paul B. Hoeber, Inc., 1930.

CAROTIDARTERIAL RENAL DISEASE; A CLINICO-PATHOLOGIC CORRELATION STUDY EMPHASIZING THE IMPORTANCE OF OPHTHALMOSCOPY. By Lawrence W. Smith, M.D.

Edward Weiss, M.D. Walter L. Little, M.D. Frank W. Koenigsman, M.D. and Edwin S. Gersh, M.D. New York and London: D. Appleton-Century Co., Inc., 1930.

DIVERTICULA AND DIVERTICULITIS OF THE INTESTINE THEIR PATHOLOGY, DIAGNOSIS, AND TREATMENT. By Harold C. Edwards, M.S. (Lond.), F.R.C.S. (Eng.). With foreword by Gordon Gordon-Taylor, O.B.E., M.S. F.R.C.S. Baltimore, Md.: The Williams & Wilkins Co., 1930.

THE THERAPEUTICS OF INTERNAL DISEASES. Edited by George Blumer, M.A. (Lond.), M.D. With the assistance of Albert J. Sullivan, M.D. Vols. 1 and 2. New York and London: D. Appleton-Century Co., Inc., 1930.

CONGENITAL CLEFT LIP, CLEFT PALATE AND ASSOCIATED NASAL DEFORMITIES. By Harold Sturges Vaughan, M.D. D.D.S., F.A.C.S. Philadelphia: Lea & Febiger, 1930.

MANUAL OF FRACTURES, DISLOCATIONS AND JOINT AFFECTIONS. By Harry C. W. S. de Bruin, M.D. F.A.C.S. Chicago, Ill.: The Year Book Publishers, Inc., 1930.

ANNUAL REPORT OF THE SEROLOGICAL GENERAL OF THE PUBLIC HEALTH SERVICE OF THE UNITED STATES FOR THE FISCAL YEAR 1930. Washington, D.C.: U. S. Government Printing Office, 1930.

THE MEDICAL CAREER, AND OTHER PAPERS. By Harvey Cushing, M.D. Boston, Mass.: Little, Brown & Co., 1930.

HANDBOOK OF OPTHALMIC SURGERY. By Alfred Russ Shanks, J. B.A., M.D., in collaboration with Richard Beverly Ramsey, B.A., M.D. St. Louis: The C. V. Mosby Co., 1930.

SURGERY

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BLOOD PRESSURE AND PULSE RATE CHANGES DURING THYROIDECTOMY

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METHOD OF APPROACH

DURING a thyroidectomy for a toxic goiter it is a universal observation that there is a rise in blood pressure and pulse rate due to the thyrotoxicosis in itself and not related to the anesthetic agent. Consequently, the value of routine blood pressure and pulse rate readings during a thyroidectomy is even greater than during other operative procedures. The character of the reaction may determine whether or not the operation is to be started, and, once started, if it is to be continued, terminated, or confined to a subtotal resection of one lobe. In order to evaluate a reaction during anesthesia one must first know what kind of reaction one should expect in a patient with moderate and one with severe thyrotoxicosis. A cursory survey of a series of anesthetic charts on thyrotoxicoses showed certain constantly recurring patterns in the blood pressure and pulse rate curves. It has been our object to determine if these patterns could be definitely correlated with the degree of toxicity. In order to do this we have made a statistical analysis of the blood pressure and pulse rate readings during anesthesia in over 600 thyroidectomies on patients with varying degrees of thyrotoxicosis.

Each clinical record was carefully analyzed to determine the type of goiter and the degree of toxicity at the time of operation. In order to make a uniform classification the preoperative dispensary record, the hospital record, the postoperative course, the pathological report, and the postoperative dispensary record were reviewed by the authors personally. This was done without reference to the anesthetic record. An average was made of the blood pressure and pulse readings taken on the ward. Likewise an average was made of the readings taken immediately preceding anesthesia. The induction of anesthesia was taken as the starting point in all cases. All the readings taken within the first 5 minutes were placed in the 5 minute column and averaged. Likewise the readings taken 10 minutes after the beginning of anesthesia were placed in the 10 minute column and averaged. The readings taken at subsequent 5 minute intervals were placed in their respective columns. The time interval between the beginning of anesthesia and the time of taking the blood pressure and pulse rate readings determined into what columns these readings fell. Obviously the duration of the operations varied, and the readings taken at a certain time interval do not always correspond to the same

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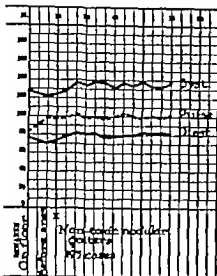


Chart. Average curves of blood pressure and pulse rate readings during thyroidectomy in 95 patients with uncomplicated, non-toxic nodular goiters.

state of the operative procedure. It was our aim to take readings at 5 minute intervals. All charts with only a few readings were discarded. In all cases in which there was hemorrhage, respiratory obstruction cyanosis or other technical complications the record was likewise discarded.

Premedication consisted of $\frac{3}{4}$ or $\frac{1}{2}$ grain (.016 or 0.01 gram) of morphine sulphate and $\frac{1}{150}$ grain (0.0004 gram) of atropine sulphate, given approximately 1 hour before operation. In more than half the cases this medication was preceded by $\frac{1}{16}$ grains (0.1 gram) to 3 grains of pentobarbital sodium at 6 o'clock in the morning of the operation. The anesthetic agent was ethylene in 90 per cent of the cases and nitrous oxide in the remaining 10 per cent. Cases in which the premedication was inadequate for nitrous oxide or ethylene anesthesia without cyanosis were excluded.

RELATIONSHIP TO TOXICITY

Non-toxic nodular goiter. The curves of the blood pressure and pulse rate readings during a thyroidectomy for non-toxic goiter offer a basis for comparing the effect of toxicity. We reviewed a series of records of patients with uncomplicated non-toxic goiters. We ac-

cepted for this series only those patients who showed no evidence of thyrotoxicosis. Borderline cases were excluded. Because we wished to establish an accurate standard for comparison we were very careful in this series to exclude all patients with any complicating disease and all cases in which there were complicating factors during the operation due to the operative procedure in itself or due to technical difficulties in the administration of the anesthetic agent.

The average curves of blood pressure and pulse rate readings during thyroidectomy in 195 patients with uncomplicated, non-toxic, nodular goiters are shown in Chart 1. Immediately before the administration of the anesthetic agent the systolic and diastolic pressure are a trifle lower and the pulse rate a trifle higher than on the ward. During the first 10 minutes the systolic pressure rises from 15 to 20 millimeters of mercury and then is maintained at a fairly constant level 10 to 12 points above the reading on the ward. The diastolic pressure rises about 10 points and remains approximately 5 points higher than the ward reading. The pulse rate changes very little, averaging 100 beats a minute throughout the operation. Although this is a fairly standard pattern, many variations may occur from this as well as subsequent patterns. In order to determine the variations from these averages we made a statistical analysis in all instances as follows. The readings, for instance of the systolic pressure taken 5 minutes after the beginning of anesthesia were arranged in a column in order of magnitude. If there are 100 such readings arranged in order of magnitude the highest, at the top of the column the lowest at the bottom number 50 will give a mean for the entire group. We found that in no instance did this figure vary more than 2 or 3 points from the calculated averages. The variation between number 25 and number 75 will give the variation of the middle 50 per cent of all the readings. Arranging all our figures in this manner we found that as regards the systolic pressures 25 per cent of the readings were within 10 millimeters above the average and 25 per cent fell within 10 millimeters below the average. This was a remarkably constant finding in every series.

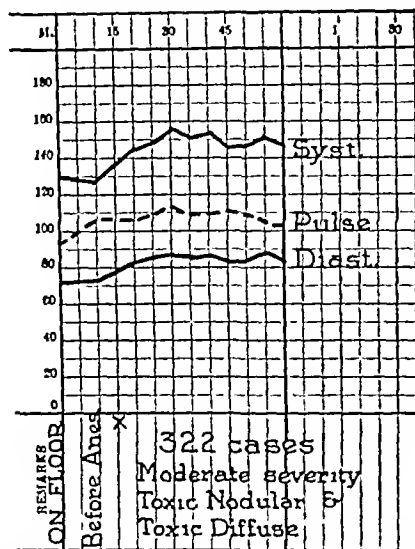


Chart 2 Findings in 322 thyroidectomies for thyrotoxicosis of moderate severity. These include patients with toxic nodular and toxic diffuse goiters

In this and all subsequent averages one can assume that 50 per cent of all systolic readings will fall within 10 points above or below the curves as shown. The diastolic pressures are not so variable, and in addition the variation above the average figure is greater than that below the average figure. Thus 25 per cent of the readings will be within 6 points above the average, and the other 25 per cent within only 4 points below the average. Roughly, however, one can assume that 50 per cent of all diastolic readings fall within 5 points above or below all the curves of average diastolic pressure. The pulse rate fluctuates more widely, and yet, with the exception of the severe toxic goiters, half of the total readings will be within 10 points above or below the average. In those patients with severe toxicosis the limits of the middle 50 per cent are 15 points on either side of the average figure.

Moderately toxic goiter (diffuse and nodular)
We divided the thyroid cases showing toxicity into 2 main groups. The degree of toxicity was estimated for the time of operation only. Estimation of toxicity was based on the following factors: pulse rate, strength, duration of illness, amount and rapidity of weight loss, and basal metabolism rate.

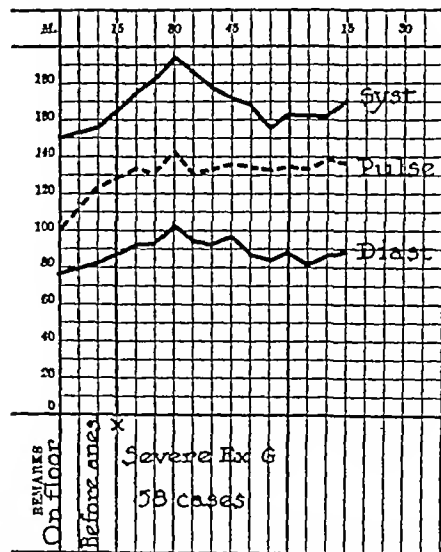


Chart 3 Blood pressure and pulse readings of 58 patients during thyroidectomies for severe toxic, diffuse, and nodular goiters

Toxic manifestations at time of operation
Obviously even after all available data are considered it is impossible to divide the cases sharply into those presenting a moderate amount of thyrotoxicosis and those showing severe toxicity. If an individual entered the hospital presenting severe toxicity but under treatment showed marked improvement, he was included in the moderately toxic group. We were more interested in the degree of toxicity that the patient actually presented at the time of operation.

Chart 2 presents the findings in 322 thyroidectomies for thyrotoxicosis of moderate severity and includes the toxic nodular and the toxic diffuse goiters. As compared with the non-toxic group, the pattern as a whole is the same. The pulse rate is about 10 points higher. Again, the systolic blood pressure shows a slight fall and the pulse rate a rise in the operating room and preceding the induction of anesthesia. During the first 10 minutes the systolic pressure shows a sharper rise of 20 points and is maintained at about 150 millimeters during the operation. The diastolic pressure is again elevated about 10 points and maintained at that level. The average pulse rate varies only a few points from 110. Most observers are under the impression that,

on the whole patients with toxic, diffuse goiters give a sharper reaction than those with toxic, nodular goiters. This is undoubtedly true for in our group of 58 severe cases, 50 had toxic, diffuse goiters and only 8 had toxic, nodular goiters. Nevertheless, a goiter of the same degree of toxicity produces the same reaction during anesthesia whether it is diffuse or nodular. The average blood pressure and pulse rate curves for 146 toxic nodular and 174 toxic diffuse goiters, both of moderate severity showed that these 2 are very nearly identical.

Severe toxic goiter (diffuse and nodular)

There were 58 patients in this group (Chart 3). In order to establish a standard for comparison we placed all borderline cases in the moderately toxic group. As a result, of a total of over 300 toxic goiters we have only 58 that we considered severe. From a purely clinical viewpoint the number would be much larger, however when one considers severity at the time of operation only the number shrinks considerably.

When the patient is brought to the operating room floor in contradistinction to the preceding groups, the systolic and diastolic pressures and pulse rate rise. After the operation is started there is a considerable additional rise in systolic pressure reaching a peak in approximately 15 minutes and then gradually dropping. The diastolic pressure rises and falls in unison with the systolic but to a much less degree. This sharp rise in systolic pressure is quite characteristic of severe thyrotoxicosis. Its rise is roughly proportional to the degree of toxicity but in the absence of true hypertension it rarely goes much above 200. Although the initial rise can be attributed to an excitation of the thyrotoxicosis, the subsequent fall is more difficult to explain. Possibly the organism adjusts itself to the insult of the anesthesia and the operation. If the pressure is maintained at a high level or continues to rise the situation is clearly less favorable. The pulse rate in this group is very high, averaging 130 in contrast with a rate of 110 in the moderately toxic and 100 in the non toxic group. The pulse rate is more variable than the blood pressure hence as stated one must allow a 15 point variation on either side of our

average curve in order to include 50 per cent of all cases. At times the pulse rate is exceedingly rapid when the patient is placed on the operating table then falls to a reasonable rate as soon as anesthesia is obtained. If a rapid rate does not subside the operation probably should not be performed. An average pulse rate of 140 or above indicates a poor risk, and one above that should command considerable respect. Not infrequently an irregularity usually an auricular fibrillation, may appear during the operation. Although this condition is by no means a source of comfort its occurrence usually causes more alarm than subsequent events justify.

The diastolic pressure varies little and is of slight importance. Thyrotoxicosis has a tendency to lower the diastolic blood pressure. If the reaction during the operation were identical to the findings in clinically severe thyrotoxicosis, the diastolic pressure should have a tendency to drop but this is not true. It was extremely uncommon to have an appreciable independent drop in the diastolic pressure but when it did occur it was always in a patient who was exceedingly ill. All that one can safely say is that a thyrotoxic patient is a sensitive individual who reacts sharply to any stress or strain and that the reaction is roughly proportional to the degree of toxicity and to the severity of the exciting factors.

LOCAL ANESTHESIA

The effect of local anesthesia was observed in a series of 25 thyroidectomies. The agent used was 1/2 per cent procaine solution without adrenalin. The cases which were considered in this series were uncomplicated and fell into the moderately toxic group and were composed of toxic, nodular and diffuse parenchymatous goiters.

The average variation in systolic and diastolic blood pressure is slight within 10 points of the reading on the ward. The pulse rate is maintained at a higher level, between 120 and 130 beats per minute throughout the operation. The pulse rate in the mildly toxic group under general anesthesia was 110. Only the very severe group under general anesthesia attained an average rate of 130 beats per minute.

The thyroidectomies on uncomplicated, non-toxic, nodular goiters were further grouped by age into decades. The maximum average pulse reading that occurred in any decade throughout the simple, non-toxic group was 108. Apparently the decade by decade group variation in blood pressure and pulse rate during thyroidectomy in the absence of toxicity or hypertension is small, but definitely present after the age of 40 years.

EFFECT OF HYPERTENSION

Thyrotoxicosis does not produce true hypertension, it elevates the systolic pressure but the diastolic pressure remains the same or, if anything, is moderately reduced. An elevated diastolic pressure is necessary for a diagnosis of essential hypertension. In the group of patients with hypertension we included only those who had a diastolic pressure of between 90 and 100 and a systolic pressure of over 190. Those with decompensated hearts, with albuminuria, or with auricular fibrillation were excluded.

It is a common notion that toxic nodular goiters have a tendency to cause hypertension. In any series of cases it will be found that more patients with a toxic nodular goiter have high blood pressure than those with a toxic diffuse goiter. This finding is due to the fact that the patients with toxic nodular goiters fall into a higher age group. If one compares the 2 types in patients of the same age group, he will find that the incidence of hypertension is the same. The increased frequency of heart complication in patients with toxic nodular goiters can be explained on the same basis. From a rough appraisal of our material it would appear that a decompensated heart as well as high blood pressure occurs in the older individuals regardless of whether they have a toxic nodular or a toxic diffuse goiter.

Chart 4 presents the average curves obtained for 28 patients with hypertension plus a thyrotoxicosis of moderate severity. There were 21 patients, of an average age of 50, with toxic nodular goiter, and only 7, of an average age of 43, with toxic diffuse goiter. The pattern is the same as for toxic goiter without hypertension except that the pressures are much higher.

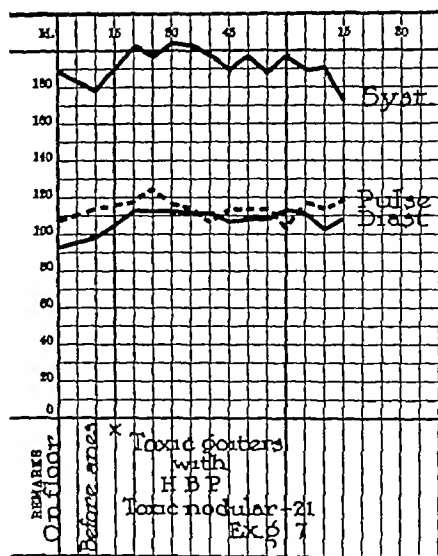


Chart 4 Average curves obtained for 28 patients with hypertension plus a moderately severe thyrotoxicosis

Occasionally during anesthesia the blood pressure will be maintained at a high level in spite of the fact that the patient originally had neither a high diastolic pressure nor a severe degree of toxicity. We have tried to explain these charts on the basis of an unrecognized hypertension or a latent hypertension. Very often one will operate on a patient with toxic goiter with a blood pressure of, let us say, 180 systolic and 80 diastolic, and find to his surprise after the thyrotoxicosis has been controlled that the blood pressure is 200 systolic and 110 diastolic. When thyrotoxicosis develops in a patient with high blood pressure, the diastolic pressure drops an appreciable amount and is invariably elevated after the operation. In such an individual the hypertension could easily be overlooked.

EFFECT OF OXYGEN DEFICIENCY

Oxygen deficiency, breathing of excessive quantities of carbon dioxide, straining, and overventilation have distinct effects on ventilation and circulation. Schneider has compared the respiratory and circulatory effects of anoxemia and carbon dioxide. Low oxygen tension effects were produced in normal individuals by rebreathing 52 liters of air from which carbon dioxide had been removed. The carbon dioxide effects were produced by re-

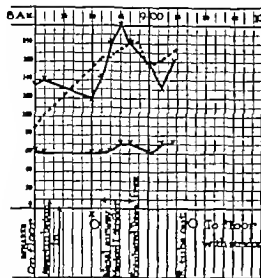


Chart 5. Effect of tracheal obstruction in the presence of thyrotoxicosis.

breathing air in which the oxygen content was maintained at 25 or 30 per cent while the carbon dioxide content gradually increased. Schneider's results are as follows:

	Anoxemia	Carbon dioxide
Average increase per cent vol. 5 hours	20	40
Average depth of breathing	250 cc	400 cc
Rate of breathing	Slightly increased	Doubled
Acceleration of pulse	20 beats	40 beats
Rise in systolic pressure	8 mm Hg	25 mm Hg
Diastolic pressure	Rise 4 mm Hg	Fall 5 mm Hg
Rise in pulse pressure	25 mm Hg	30 mm Hg
Capillary pressure	No change	Rise 5 mm Hg
Venous pressure	Fall 4.5 cm H ₂ O	Rise 4.5 cm H ₂ O

These effects vary in degree in different individuals. A patient with thyrotoxicosis tolerates oxygen want less readily than a normal person hence the changes due to anoxemia are exaggerated in the presence of thyrotoxicosis. It is obvious that a rise in blood pressure and pulse rate of considerable magnitude can occur from anoxemia alone. Indeed it may be difficult at times to distinguish between the two. Thus if during the conduct of anesthesia in a thyrotoxic patient the curves of the systolic and diastolic pressures and the pulse rate rise the anesthetist

must make doubly sure that the rise is not due to anoxemia or carbon dioxide rather than thyrotoxicosis.

Chart 5 shows the effect of tracheal obstruction in the presence of thyrotoxicosis. The patient had a severe toxic diffuse goiter for which a subtotal resection of the right lobe had been performed 6 weeks previously. The right recurrent laryngeal nerve had been paralyzed at that time. In the course of the second operation the lower portion of the inferior thyroid artery was injured. As the bleeding was controlled a marked inspiratory stridor developed. Sufficient oxygen was given under pressure to prevent cyanosis. The systolic blood pressure rose to 200, the pulse rate to 180. As the pressure began to fall and the pulse rate became poor in quality an endotracheal tube was inserted. The patient's condition improved almost instantly although the pulse rate remained very rapid. Tracheotomy was necessary upon removal of the endotracheal tube.

EFFECT OF HEMORRHAGE

An extensive loss of blood during a thyroidectomy produces the same circulatory changes as in any other operation (3). The slowed circulation and the loss of oxygen-carrying erythrocytes cause a decrease in the oxygen content of the blood although the percentage of carbon dioxide is not materially altered. These changes are related not so much to the actual quantity of blood lost or to the amount lost in relation to the body weight as they are to the rate of blood loss. If oxygen lack is continued too long the damage will be permanent.

It cannot be overemphasized that when the anesthesia record first indicates a loss of blood danger is imminent. Pflüger has estimated an average loss of blood in thyroidectomies of 100 cubic centimeters and a maximum loss of 300 cubic centimeters. In a difficult operation a loss of 1,000 cubic centimeters is not impossible.

The effect of the loss of blood on the anesthesia record in a thyroidectomy is the same as in any other operation, i.e., a recession of the systolic and diastolic pressure accompanied by an increase in pulse rate (Chart 6).

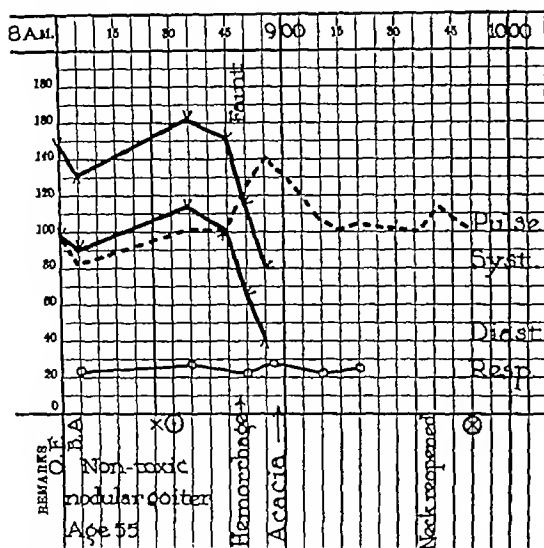


Chart 6 Graph showing recession of the systolic and diastolic pressure accompanied by an increase in pulse rate due to hemorrhage

There is this difference, however. In thyrotoxicosis, as has been shown, the systolic pressure rises as the pulse rate rises, consequently, if one finds a rise in pulse rate with even a stationary blood pressure, he can suspect excessive bleeding.

TWO STAGE OPERATIONS

A second stage operation offers an opportunity to compare the effect of the anesthetic agent and the operation on the same patient, who now presumably has a lesser degree of toxicity than in the first operation. We compared the averages of 22 patients (Chart 7) with severe toxic diffuse goiter who had 2 operations, a subtotal resection of the right lobe followed in approximately 6 weeks by a subtotal resection of the left lobe. At the time of the second operation it seemed that each patient showed some improvement, and yet in many it was difficult to demonstrate this definitely. Nearly all had a gain in weight, this was the most constant evidence of improvement. At the second operation the patient is still very sick although he is much less likely to die. It is apparent that the reaction during the second operation will be very similar to the reaction during the first operation, and that whatever improvement has been ob-

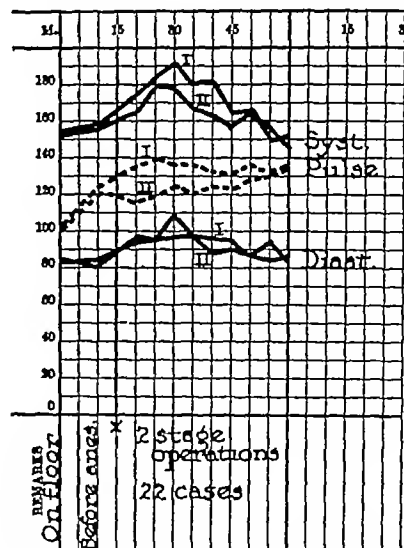


Chart 7 Averages computed in 22 patients suffering with severe toxic, diffuse goiters who had 2 stage operations

tained is evidenced largely by a drop in the pulse rate.

DEATHS

It is the record of the patient who dies that in the final analysis forms the basis of judgment in evaluating the risk. By comparing the reaction during the operation with that after the operation in a large series of cases, one finds a definite correlation between the two. There are many exceptions. In some cases the reaction during operation is severe and the postoperative course is stormy. The judgment of risk based upon pre-operative clinical data is much more accurate than judgment based upon the behavior of the patient during the operation. This is as one would expect. It is more clearly seen when one analyzes the deaths. In the case of most patients who die, death results apparently from a postoperative exacerbation of the thyrotoxicosis, and the anesthesia chart shows evidence of severe toxicity. Yet it is possible to collect a series of charts showing a similar reaction during anesthesia in patients who not only did not die but who had a smooth recovery. Recovery from the operation depends to a much less degree upon the character of the reaction than it does upon the patient's ability to withstand the reaction. Neverthe-

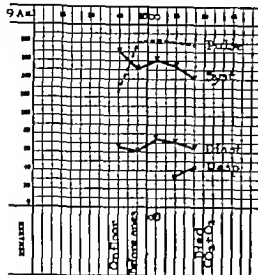


Chart 8. Pulse, blood pressure, respiration, Case

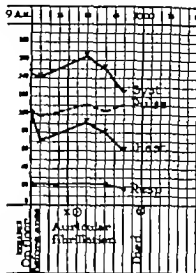


Chart 9. Pulse, blood pressure, respiration, Case

less, there are operations during which the reaction indicates that it would be wise to terminate them immediately regardless of the surgeon's confidence in the infallibility of his criteria of operability. Conversely there are those in which a reaction of only moderate degree may influence the surgeon to do a one stage rather than a two stage operation.

What then is the reaction during operation of these patients who died? To answer this question we have gathered the deaths from this series of cases and included only those in which the deaths were due to a thyroid crisis

CASE 1. A colored woman, 43 years old, had nervousness and goiter for 4 years, dropsical palpitation, and edema for years, and loss of 5 pounds in eight during the past year (Chart 8). The basal metabolic rate was $+76$. The pulse rate was 70 to 80 and the blood pressure 7/66. The Wassermann reaction was 3. albuminuria () was present. Moderate exophthalmos and moderate degree of nervousness and tremor were present. The thyroid gland was diffusely enlarged about three times its normal size. Bruit could be heard over each superior pole.

Ten drops of Lugol solution was given 3 times a day for 4 weeks. The weight remained the same for this period. The patient was able to walk about but was rather calm.

The pulse rate was 76 before the anesthesia was started and remained about that level during the operation. Both lobes were removed. While the wound was being closed the pulse suddenly became

imperceptible, and as suddenly the patient died. The autopsy showed marked hyperplasia of the thymus, generalized lymphadenopathy, luetic aortitis, eccentric hypertrophy of the left heart, congenital narrow aortic orifice, marked decrease of the lipid content of the adrenals, and lymphoid hyperplasia of the gastro-intestinal tract.

When the pulse rate remains at 180 after the anesthesia has been started, it would be better to postpone the operation. If the pulse rate is maintained at that level it is folly to remove both lobes. An exception occurs in children under 12 years of age in whom the pulse is invariably so exceedingly rapid that one expects a rate of 160 to 180 beats per minute.

CASE 2. L. D. woman aged 39, developed goiter and symptoms of thyrotoxicosis following the death of her husband 7 years previously (Chart 9). Rather suddenly she became very nervous and weak the heart as rapid and irregular the weight dropped from 70 to 50 pounds. Her feet began to

swell and she became so short of breath that she was obliged to remain in bed for 3 months. For the past 3 months she had been much better. The thyroid gland was diffusely enlarged to about 3 1/2 times its normal size. An exophthalmic stare was present. There were multiple fibroids of the uterus the mass reached to the umbilicus. The heart was slightly enlarged and fibrillating the pulse rate averaged about 90 beats per minute. The blood pressure was approximately 110/60. The basal metabolic rate 7 days prior to operation was $+84$; 7 days prior to operation, $+70$, and 7 days prior to operation, $+96$.

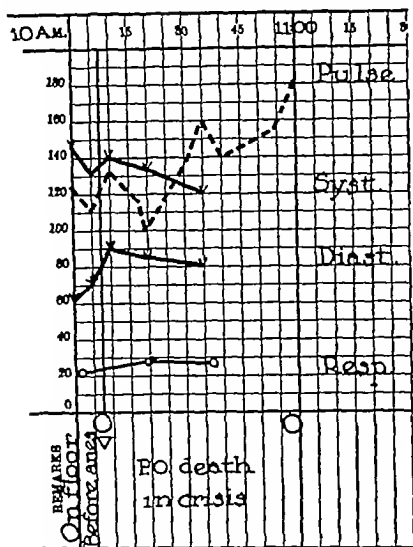


Chart 10 Pulse, blood pressure, respiration, Case 3

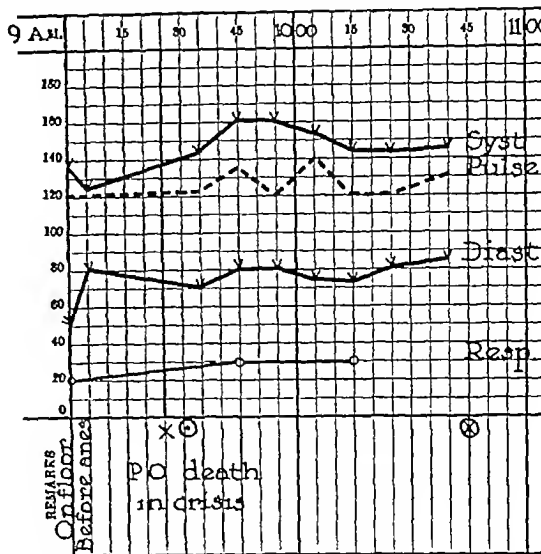


Chart 11 Pulse, blood pressure, respiration, Case 4

The weight dropped 2 pounds during this time. This decrease was attributed to the loss of water in the edematous extremities. The patient was given Lugol's solution for 4 weeks and tincture of digitalis for 6 weeks.

The anesthetic chart is that of an uneventful operation. The chart is misleading in that the patient had a rapid auricular fibrillation making accurate observations of blood pressure and heart beat impossible. The course of both the operation and the anesthesia was uneventful until, at the end of the operation, very suddenly the patient's respirations became shallow, and almost immediately the pulse could not be felt in the wrist, cyanosis developed, the pupils dilated, and in a moment the patient was dead. The pathological diagnosis was toxic, nodular goiter. The autopsy showed chronic, myocardial fibrosis and degeneration, a myomatous uterus, right hydropelvis and hydro-ureter with pyelonephritis.

There is nothing in the anesthesia record to foretell such a catastrophe. It must be remembered, however, that the patient had an auricular fibrillation, in such a condition the pulse rate and the blood pressure readings are very inaccurate. With fibrillation it is well for the surgeon to feel the beat at the apex or along the carotid vessels during the course of the operation and compare the rate with the pulse in the peripheral vessels in order to assure himself that the pulse deficit has not reached an alarming figure. In this case the smoothness of the operation influenced the

surgeon to complete the operation in 1 stage. In Case 1, the surgeon continued in spite of the warning signs. In both he was wrong.

CASE 3 S P, a woman of 18 years had a goiter, nervousness, weakness, palpitation and dyspnea for the past 4 months (Chart 10). During that time she had lost 40 pounds in weight. A month ago she had an attack of nausea and vomiting. She had been taking 10 drops of Lugol's solution 3 times a day since the beginning of the symptoms without much improvement. The thyroid gland was diffusely enlarged and there was a moderate exophthalmos. She was in the hospital for 1 month. The basal metabolic rate rose from +44 to +49 and the weight dropped from 62 to 59 pounds. The pulse rate ranged from 100 to 120. The blood pressure was 146/100. Her strength improved so that she could be up and about out of bed, although she remained quite emaciated and very weak.

Lobectomy was performed under local infiltration anesthesia, a 0.5 per cent solution of procaine hydrochloride being used. During the operation the pulse rate rose until it became too rapid to count. Although the blood pressure usually rises with a rise in the pulse rate, in this case it dropped from 140 to 120 systolic. The loss of blood was larger than the average and may account for some of this fall. She left the operating room in poor condition. That night the blood pressure was 100/60, the temperature 102.2 degrees F and the pulse rate 160. The patient seemed better. The temperature never rose above 101.2 degrees F. Toward evening she became much worse and died from acute thyrotoxicosis, at about the time most of such patients do die, that is, between 36 and 48 hours following the operation.

The pathological diagnosis was diffuse parenchymatous goiter. No autopsy was performed.

From this case it can be seen that the pulse rate is a better index of the severity of the thyrotoxicosis than is the blood pressure.

CASE 4. E. B. woman aged 17 had symptoms for 6 months (Chart). She lost pounds in weight but gained them back. She was not very ill. The basal metabolic rate was $+3$. On the second day following subtotal resection of both lobes, she became very ill, and died on the fourth day with temperature of 105 degrees F. The goiter was of the toxic, diffuse variety. The autopsy showed a dependent congestion of both lungs, with early bronchopneumonia of the right lower lobe, hyperplasia of the thymus, and generalized abdominal lymphoid hyperplasia.

In this case neither the clinical history nor the course during operation gave the observer the slightest hint that this patient would die in a crisis. Although she did have some evidence of bronchopneumonia on postmortem examination it was felt that death was caused by acute thyrotoxicosis.

SUMMARY

The blood pressure and pulse rate readings during thyroidectomy are analyzed in over 600 patients, with varying degrees of thyrotoxicosis.

An effort was made to correlate the changes during operation with the clinical picture. The readings were averaged in certain groups of cases and a composite chart of the averages was made as follows. The average curves in 195 cases of uncomplicated non-toxic goiter; the average curve in 322 cases of moderate severity; the average in 58 cases with severe thyrotoxicosis; the effect of hypertension on the anesthetic record; the effect of respiratory obstruction; the effect of hemorrhage; a comparison of the averages in the first and second stage of 22 cases with 2 stage operations; and the anesthetic records for 4 deaths during or following thyroidectomy.

There appears to be a direct relationship between the rise in blood pressure and the degree of toxicity at the time of operation. Although this reaction may be sharp it is the pulse rate that gives the best index as to prognosis.

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ANESTHESIA AND ANOXEMIA IN RELATION TO THE USE OF NITROUS OXIDE

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RECENT medical literature has brought forth a wealth of articles dealing with the subject of untoward effects following nitrous oxide anesthesia. There is a difference of opinion regarding the etiology of these effects, some hold that anoxemia, or tissue anoxia, is responsible, while others maintain that when nitrous oxide is followed by undesirable effects, these are a manifestation of a toxic action of the nitrous oxide itself.

This subject deserves all the consideration and research which it is receiving at present, but it appears that certain important clinical points have been overlooked in the discussion. This is due to the fact that there have been certain errors present in the clinical use of this drug, and these errors have come to be looked upon as truths, through long usage, particularly by those with little or no clinical experience. It is unfortunate that this has been so, but it is a good sign when the laboratory worker interests himself in the subject, thus bringing to light certain clinical faults. Unfortunately, except in a few centers, anesthesia has received but little attention by competent and interested clinicians. In this country it has been the task of the nurse or junior interne, neither of whom has been able or willing to be more than a technician. Unfortunately, too, some recognized authorities have set forth the dictum that anoxemia during the administration of nitrous oxide is a normal and harmless condition (6). This has been thought to be true especially if the person administering the anesthetic agent has had a large number of previous asphyxiations to his credit. The weakness of this idea lies in the fact that the tissue cells do not know who is depriving them of their necessary oxygen, and thus suffer as much damage at the hands of the expert as of the novice. Undoubtedly a large amount of damage has been done by

administering nitrous oxide without sufficient oxygen. This is because wrong methods have been used, and it should be recognized that the damage is due to anoxemia.

In recent publications, Lowenberg and his associates have stated that nitrous oxide has toxic properties. A careful perusal of their case reports shows evidence, either direct or presumptive, of oxygen want in all the cases considered.

Either nitrous oxide is toxic or it is not. If toxic, it is possible that such toxicity becomes manifest only in case the patient is susceptible or in poor condition, if not toxic, the damage which is admitted must be due to the presence of some other factor. The purpose of this paper is to review the subject of nitrous oxide anesthesia from a clinical rather than a laboratory standpoint in an attempt to discover the fault.

PHARMACOLOGY OF NITROUS OXIDE

Although the work of Gianotti and Vannotti would seem to point to toxic properties inherent in nitrous oxide, it has been accepted by clinical anesthetists (Waters, etc.) that nitrous oxide is neither toxic, in the ordinary sense, nor is it irritating to the tissue. This is a very important question. We do know that this gas has a narcotic or anesthetic effect when inhaled. It is for this effect that the drug is given. There seems to be no evidence that patients have suffered ill effects when nitrous oxide has been given *in the presence of sufficient oxygen*. Greene and his associates state that beyond a certain point, the depth of anesthesia depends upon the oxygen want rather than upon the concentration of nitrous oxide. It is at the greater depths of so called nitrous oxide anesthesia that asphyxia enters the picture. Since it is necessary to produce different depths of anesthesia under different circumstances, we should evaluate nitrous oxide from a clinical standpoint and

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place it in its proper niche among anesthetic agents as regards what may be called its potency. This brings us to a fact which is not sufficiently well known, namely nitrous oxide is a very weak anesthetic. Although it will produce sleep in most patients, it does not possess the property of producing muscular relaxation. This lack of effectiveness is inherent in the drug itself and is in no way due to the method of administration or the apparatus used. Since nitrous oxide produces otherwise a very pleasant anesthesia, attempts are constantly made to use it in cases in which muscular relaxation is necessary. These attempts must include the introduction of some other agent which will produce the necessary relaxation. In general such adjuncts fall under 4 headings: (1) premedication, (2) local or regional block, (3) addition of other general anesthetic agents, inhalation, rectal, intravenous, and (4) addition of asphyxia. Note that asphyxia is spoken of as being added. It is not a normal part of anesthesia.

The habit of fortifying nitrous oxide anesthesia with some degree of asphyxia has become so common that most people regard it as a regular part of the picture. It is to eradicate this false and most dangerous belief that this communication is presented. It can not be too strongly or clearly stated that *asphyxia should not be a normal accompaniment of nitrous oxide or any other anesthetic agent*. If it is present either by accident or design, it is dangerous, and should not be allowed to persist under any consideration.

It follows therefore that if by the term surgical anesthesia, we mean a state in which muscular relaxation is present with adequate oxygen concentration, there is no such thing as surgical anesthesia produced by nitrous oxide and oxygen. The appreciation of this fact casts a new light on the statement of various authors in connection with untoward effects of so called nitrous oxide anesthesia. When Greene and his co-workers stated that the depth of anesthesia depends upon the oxygen content of the blood, they were right only up to a certain point. The added depth of anesthesia obtained with lower concentrations of oxygen was not anesthesia at all but a superimposed asphyxia.

Hewitt, in 1899 observed that various accompaniments of nitrous oxide anesthesia were due to oxygen want and pointed out that these symptoms were not a part of true anesthesia. Brown, Lucas, and Henderson state that patients anesthetized with nitrous oxide will always suffer from a severe degree of anoxemia, and thus must impose a limitation upon its use and increase its danger. These authors also fall into the common error of assuming that surgical anesthesia is possible with nitrous oxide, and that asphyxia is a part of normal anesthesia.

It is true then that nitrous oxide properly given has very definite limitations as an anesthetic agent. This being the case it follows that if muscular relaxation is present with nitrous oxide there must be more or less anoxemia. It is also true that we must have muscular relaxation to perform a laparotomy successfully. Therefore any report of a laparotomy done under nitrous oxide anesthesia is also a report of a case of anoxemia. Bearing this in mind, it would seem that there is evidence that anoxemia was present in all the cases reported by those who have written on the damage done by nitrous oxide anesthesia. We certainly cannot disregard the possible effect of such anoxemia. I believe that Lowenberg and his associates have been in error in not recognizing this fact. Their pathological findings are above reproach, but they have not sufficiently considered the clinical data. This has led to the drawing of wrong conclusions.

A review of the subject of nitrous oxide as an anesthetic agent resolves itself into a consideration of the pharmacology of nitrous oxide and its properties as an anesthetic. Nitrous oxide is a relatively weak anesthetic, therefore its use must be confined to those cases in which muscular relaxation is not desired, or to produce sleep only in cases in which relaxation has been produced by other means.

If the limitations of nitrous oxide are understood and too much is not expected of it, it takes its proper place in the armamentarium of the anesthetist. Its use is indicated in operations not involving muscular structures.

If nitrous oxide is given with sufficient oxy-

gen, it can be given safely for any length of time and to patients of any age. It was formerly believed that its use was unsafe in the case of children. Any ill effects following its use in this class of patients has been due to the fact that children are more susceptible to anoxemia than adults. If anoxemia is avoided, this objection disappears.

Nitrous oxide has also been said to be suitable only for short operations. This is also a mistake. Naturally, an hour of anoxemia is more dangerous than 5 minutes. If the anoxemia is avoided, nitrous oxide anesthesia may be maintained as long as necessary.

The use of nitrous oxide in obstetrics should receive special mention. It has been suggested that this drug was a possible factor in the production of cerebral damage in the newborn. The recent studies of Schreiber and Gates would seem to place the fault elsewhere and to confirm the belief that nitrous oxide itself is harmless, provided sufficient oxygen is given with it.

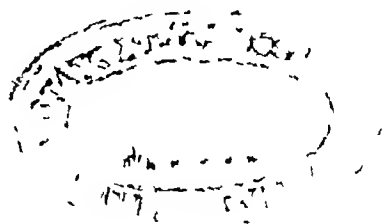
Anoxemia has long been known as a dangerous condition. Nitrous oxide, on the other hand, has long enjoyed a reputation of harmlessness. When both are shown to have been present and damage has resulted, it seems unreasonable to blame the nitrous oxide

without first proving beyond doubt that the more obviously dangerous anoxemia has had no ill effects.

The abandonment of the secondary saturation technique, the promiscuous use of nitrous oxide by unskilled attendants and others in dental offices, and the "pushing" of nitrous oxide in surgical cases, will soon prove that asphyxia not anesthesia with nitrous oxide is responsible for the untoward effects which recently have been receiving attention.

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DISTURBANCES IN THE CIRCULATION AND RESPIRATION IN OBSTRUCTION OF THE BLOOD FLOW TO AND FROM THE HEART

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THE surgical treatment of various diseases of the thorax has made rapid advances during the past two decades, and at the present time thoracic surgery enjoys a wide scope of application. Not only has the mortality and morbidity of certain diseases been drastically reduced but still other conditions, formerly thought to be incurable, are now found to be amenable to surgical therapy.

Factors responsible for this advancement include a thorough understanding of the cardiorespiratory physiology under normal conditions and its variation with disturbance of intrathoracic pressures. It is only natural that as more pathological processes were attacked, the problems to be solved became more in- stead of less complex and at present many obstacles still remain. Of these obstruction of the superior vena cava by tumor, thrombosis, infection, or mediastinal emphysema, occlusion of the pulmonary arteries by emboli, valvular stenosis and insufficiency, and acute cardiac embarrassment by tamponade comprise only a few. In order better to understand the fundamental derangement of the normal physiology brought about by these pathological entities, an attempt was made to simulate the conditions in experimental animals by obstruction of the large vessels leading to and from the heart.

EXPERIMENTAL METHOD

Only normal healthy dogs were used and were given a pre-operative dose of $\frac{1}{4}$ to 1 grain of morphine. The experiments were of an acute nature, i.e. the animal was not allowed to live after the experiment ended. Intratracheal insufflation ether anesthesia was employed. Occlusion of the superior and in-

ferior vena cava individually and together of the main pulmonary artery alone and of its branches individually and together of the aorta alone or in combination with occlusion of the main pulmonary artery were carried out.

The arterial pressure was obtained from the carotid artery in the usual manner and recorded by a kymograph. The venous pressure was obtained from the external jugular vein in the neck, the cannula being directed centrally in order to record the variations of pressure coming from the right heart. The left auricular pressure was obtained from the left inferior pulmonary vein. A long cannula was used in order to reach the auricle and was maintained in position by means of a ligature. The tube which connected the cannula with the mercury manometer was passed through a stab wound in the left sixth intercostal space and the pressure was recorded by the kymograph. A tracing of the respiratory movements was obtained by means of a tambor connected with a bellows which was secured around the body of the animal at the level of the tenth intercostal space.

EXPERIMENTS

Group 1. Obstruction of the aorta (arch) in 3 dogs. The carotid and jugular pressures were obtained as described. The chest was opened through the left fifth intercostal space. The auricular pressure and the respiratory curve were recorded with the described technique. The aorta was isolated and occluded immediately outside of the pericardium proximal to the innominate artery.

Protocol 1 dog 645. Aortic occlusion for 6½ minutes with recovery of only respiratory movements following cardiac massage (Fig. 1).

Positive pressure intratracheal ether anesthesia was used and the chest was opened through the

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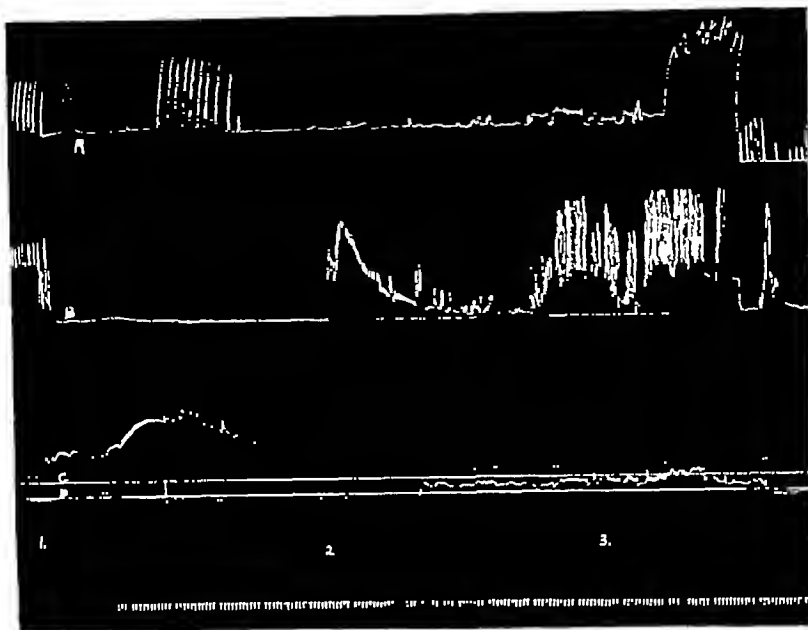


Fig 1 Dog 646 Obstruction of aorta for $6\frac{1}{2}$ minutes Note A, Respiration, B, carotid, C, left auricle, D, jugular, 1, obstruction of aorta, 2, release of obstruction, 3, cardiac massage There was spontaneous recovery of respiratory effort although irregular in frequency and force. No cardiac recovery with massage of the heart

fifth left interspace The aorta was isolated and occluded with a soft clamp The carotid pressure fell acutely to almost 0 There was spontaneous recovery on release of the obstruction $6\frac{1}{2}$ minutes later but the carotid pressure again fell to almost 0 within 3 minutes The jugular pressure presented a delayed rise of a few millimeters The auricular pressure showed a progressive rise to 44 millimeters of mercury The contractions of the auricles were still present $4\frac{1}{2}$ minutes after the occlusion and the auricular pressure remained high during the entire obstructive period The respiratory movements ceased during the first 2 minutes, then reappeared for 2 minutes and were of good amplitude They stopped completely after $4\frac{1}{2}$ minutes of aortic occlusion Following release of the occlusion, massage of the heart gave rise to spontaneous respiratory movements 12 minutes after the last previous respiratory effort, but no cardiac response was noted The occlusion was maintained for $6\frac{1}{2}$ minutes

The other dogs in this group showed records similar to the one just described

Figure 2, dog 558, illustrates an example of aortic occlusion for 2 minutes The carotid pressure exhibited a sudden sustained fall to a very low level with just as rapid return to a higher level as before, on release of the obstruction A rapid secondary fall and return was a characteristic carotid pressure reaction in obstruction of the aorta

The jugular pressure showed an immediate rise to 20 millimeters of mercury, then a fall to the original level At this time no more pulsations were seen in the jugular curve (respiratory movements) whereas the auricular curve (left auricle) showed regular contractions The auricular pressure presented a sustained rise of 20 millimeters of mercury

This is a typical example of recovery after a short period ($1\frac{1}{2}$ minutes) of occlusion of the aorta

Group 2 Pulmonary artery obstruction in 10 dogs The pressures were taken, as heretofore mentioned The left chest was opened through the fifth left interspace An incision was made in the pericardium, the main pulmonary artery was isolated from the aorta and was completely obstructed with a soft clamp

Protocol 2, dog 558 Pulmonary artery obstruction for 1 and $1\frac{1}{2}$ minute periods with recovery (see Fig 3)

The carotid pressure showed a sudden sustained fall to about 20 millimeters of mercury On release of the obstruction a fairly rapid return to normal within $\frac{1}{2}$ to 1 minute occurred The jugular pressure presented a delayed rise of only a few millimeters with a somewhat gradual return to normal



Fig. 2. Dog 558. Obstruction of aorta for $\frac{1}{2}$ minutes. Note A, Carotid B, jugular C, left auricle 1, obstruction of aorta, 2, obstruction released 3, resumption of respiration, gasping in character

after release of the obstruction. The auricular pressure was little affected. The pulsation became weaker but continued during the obstructive period. The respiratory movements as reflected in the jugular and auricular tracings became irregular in rhythm, rate, and force and ceased entirely during the second period. This protocol is quite representative of this group of dogs. The tracing of the respiratory movements of dog 617 revealed marked irregularity and slowing during the $3\frac{1}{2}$ minutes of obstruction followed by spontaneous recovery although some irregularity was present. There was



Fig. 3. Dog 558. Obstruction of pulmonary artery. Note A, Carotid B, jugular C, left auricle 1, obstruction 2, release 3, obstruction 4, release. The respiratory action is reflected in both jugular and auricular tracings

spontaneous recovery of the respiratory effort in another dog following $5\frac{1}{2}$ minutes of obstruction (Fig. 4, dog 618)

In these 2 two dogs, although there was spontaneous recovery of respiratory movements, in neither one could normal cardiac activity be restored by massaging the heart.

In 4 of 10 animals the effect of occlusion of the right and left pulmonary arteries individually with the left chest open was studied. This was done before and after the insertion of a cannula into a left pulmonary vein for recording the auricular pressure

Figure 5 dog 615 reveals the changes observed when the left pulmonary artery was occluded. Practically no change in the carotid pressure as noted, 2. When the right pulmonary artery was obstructed, 3, 4, the carotid pressure was lowered

about 8 millimeters of mercury. When, after having occluded the right pulmonary artery, a left pulmonary vein was obstructed, the carotid pressure fell still further due to the added resistance to the blood flow.

As was expected, the changes in the jugular and auricular pressures and the respiratory movements were the same as in occlusion of the primary pulmonary artery.

Group 3 Obstruction of the pulmonary artery and aorta (together) in 6 dogs. The various pressures were obtained as herein described. The approach was made through the left fifth intercostal space. The obstruction of both vessels was accomplished with a soft clamp inside of the pericardial sac through an opening made over the region of the left auricular appendage.

Protocol 3, dog 957. Aorta and pulmonary artery obstruction for 2 and 2½ minute periods with complete spontaneous cardiac and respiratory recovery (see Fig. 6).

The carotid pressure showed an immediate fall to 30 millimeters of mercury with a gradual return to 130 millimeters of mercury (the pre-occlusion pressure) on release of the obstruction. The jugular pressure gradually increased to 12 millimeters of mercury which was fairly well sustained until the obstruction was released. The pulsations of the right auricle and the respiratory movements are recorded in the jugular tracing. In 2 periods of 2 and 2½ minutes of obstruction, the left auricular tracing showed a very sharp rise in pressure of 46 and 20 millimeters of mercury respectively, with a rapid fall to minus 6 within 1½ minutes, remaining negative until the obstruction was released. Pulsations of the auricle and respiratory movements are both recorded in the left auricular tracing, the former being present only a part of the time. The respiratory movements remained fairly regular during the first 2 minutes of obstruction, they gradually became slower and somewhat irregular, but became normal spontaneously on release of the obstruction. After 5 minutes of obstruction, massage of the heart stimulated no cardiac activity, but the respiratory movements returned again spontaneously.

The other dogs in this group produced very similar pressure tracings.

Group 4 Obstruction of venæ cavæ in 12 dogs. The various pressures were recorded in the usual manner. In most cases the approach was made through the right fifth intercostal space, in others through the left fifth intercostal space, and the venæ cavæ were reached through an opening in the mediastinum. The

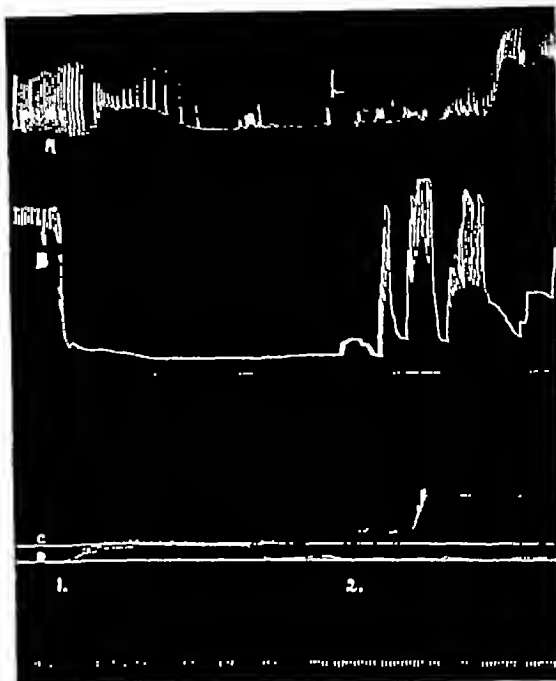


Fig. 4 Dog 648 Obstruction of pulmonary artery for 6½ minutes with spontaneous recovery of respiration but no recovery of cardiac action with cardiac massage. Note A, Respiration, B, carotid, C, left auricle, D, jugular, 1, obstruction, 2, release.

superior and inferior venæ cavæ were occluded individually and simultaneously. The vena azygos was also obstructed.

Protocol 4, dog 82. Complete vena caval obstruction for 70 seconds (Fig. 7).

The right pleural cavity was opened through the seventh right interspace. The azygos vein was ligated. Little change in blood pressure was noted. The superior and inferior venæ cavæ were clamped simultaneously. There was an immediate sustained fall of the carotid pressure to 10 millimeters of mercury, and 70 seconds later an immediate return to the pre-occlusion level on release of the obstruction. The jugular pressure gradually rose to 22 millimeters of mercury and returned to a normal level immediately after release of the obstruction. The auricular pressure fell 6 millimeters of mercury below its previous value and after release showed a sudden rise, reaching 6 millimeters of mercury above its pre-obstructive level, followed by a gradual return to normal.

The effect of vena caval obstruction on respiration was well illustrated in dog 640 (Fig. 8).



Fig. 5. Dog 650. Obstruction of the right and left pulmonary artery individually—obstruction of left inferior pulmonary artery with left chest open. Note: Occlusion of left pulmonary artery: 2, release of same: 3, occlusion of right pulmonary artery: 4, release of same: 5, occlusion of right pulmonary artery: 6, obstruction of left inferior pulmonary vein: 7, release of same: 8, release of artery: 9, occlusion of left inferior pulmonary vein: 10, release of vein.

The respiratory movements became gradually slower were irregular in rhythm and force, and ceased entirely after $4\frac{1}{2}$ minutes of obstruction. On release after $7\frac{1}{2}$ minutes of occlusion there was spontaneous recovery of respiratory function. (The heart continued to beat regularly throughout this period.) After $13\frac{1}{2}$ minutes of obstruction of the vena cava, the aorta was momentarily obstructed and the superior vena cava momentarily opened allowing little blood to go to the heart (Fig. 6, dog 650 — 2, 6).



Fig. 6. Dog 957. Occlusion of pulmonary artery and aorta for 2 and $\frac{1}{2}$ minute periods till recovery. A, respiration; B, carotid; C, left auricle; D, jugular. occlusion: release: 3, occlusion: 4, release.

Recovery of respiratory function was noted in some animals after release of obstruction of the vena cava lasting as long as 10 minutes, although during the first 3 minutes after release of the clamp artificial respiration and massage of the heart was instituted (dog 650).

In order to determine the relative influence on the pressure changes observed, each vena cava was occluded individually (dog 398). The occlusion of the superior vena cava was accompanied by a fall of about 33 per cent in the carotid pressure (Fig. 9 A, 2) whereas a fall of about 60 per cent was observed when the inferior vena cava was obstructed (Fig. 9, A, 3). Figure 9 B and C illustrate the effect of occlusion of one vena cava following the other beginning with the vena cava superior in B (Fig. 9) and with the inferior in C (Fig. 9).

Other phenomena observed included the heart which became smaller in size but the impulse was regular for as long as 7 minutes of obstruction. The lungs decreased in size and became pale. With the release of the obstruction, if recovery did not take place the most outstanding finding was a marked dilatation of the right auricle. After observing these phenomena, instead of releasing both vessels simultaneously we first released only the superior vena cava and after 2 to 3 minutes the clamp on the inferior vena cava was removed. The heart tolerated release of obstruction of the vena cava individually better than simultaneously.

ANALYSIS OF EXPERIMENTS

When these experiments were begun, a more abrupt fall in the carotid pressure was anticipated in obstruction of the aorta than in obstruction of the other vessels. However, the carotid pressure fall was found to be similar in obstruction of all vessels entering or leaving the right or left heart. The recovery period on the other hand, exhibited a characteristic carotid pressure curve for the various vessels obstructed. With release of obstruction of the pulmonary artery, recovery of carotid pressure was quite gradual, whereas release of obstruction to the venæ cavæ or aorta resulted in a rapid return of carotid pressure to its original level. This can best be explained by the rapid tiring of the right heart muscle due to increased strain and dilatation during pulmonary artery obstruction. The left heart muscle on the other hand was not weakened to the same degree by the same period of obstruction of the aorta. In obstruction of the venæ cavæ the heart continued to beat but against greatly decreased pressure and could be compared to a motor running idle.

From the individual occlusion of the right or left pulmonary artery one learned that this type of obstruction decreased very slightly the arterial pressure and was perfectly tolerated. With the left chest open the carotid pressure varied following the occlusion of the left or the right pulmonary artery. The occlusion of the left pulmonary artery scarcely modified the blood pressure whereas obstruction of the right pulmonary artery resulted in a definite reduction in carotid pressure. This suggested strongly that the blood flow through the partially deflated lobes had been diminished.

In order to measure the auricular pressure a cannula was inserted into a left pulmonary vein since we wanted to know the effect of its occlusion upon the blood pressure. We not only observed that its occlusion diminished by 6 millimeters of mercury the carotid pressure but that when the right pulmonary artery was closed the obstruction of this vein produced a fall of 60 millimeters of mercury in the arterial pressure. This was explained by the fact that the entire blood stream had been



Fig 7 Dog 82 Obstruction of both venæ cavæ and azygos vein A, Carotid, B, jugular, C, left auricle, 1, occlusion, 2, release

diverted through the partially deflated left lung.

A sudden fall in the carotid pressure was unexpected in vena caval obstruction since it is reasonable to assume that the blood contained within the lesser circulation would be a source of supply for the general circulation for the period immediately following obstruction.

In every type of obstruction the jugular pressure was increased, reaching levels from 10 to 15 millimeters of mercury in obstruction of aorta, pulmonary artery, or aorta and pulmonary artery together. The pressure was elevated still more with obstruction of the venæ cavæ, reaching from 20 to 40 millimeters of mercury. In the case of operation for pulmonary embolism Kiser advises obstruction of the circulation on the venous side of the heart. He states that this should be better tolerated than obstruction on the arterial side,

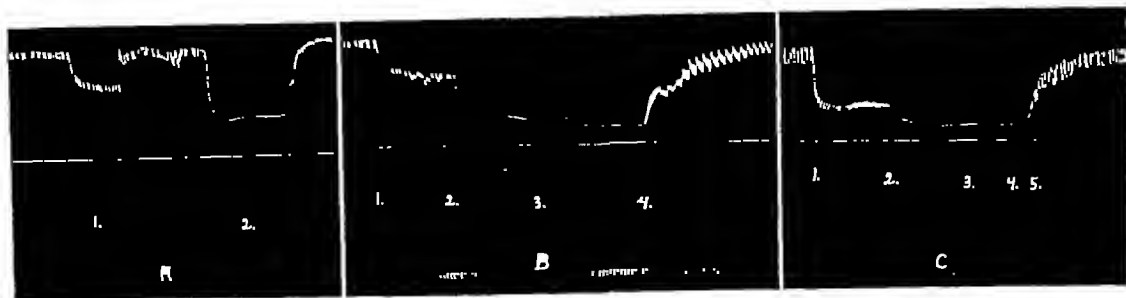


Fig 9 Dog 398 Obstruction of venæ cavæ individually and together A, 1, Obstruction and release of superior vena cava, A, 2, obstruction and release of inferior vena cava, B, 1, obstruction of superior vena cava, B, 2, obstruction of inferior vena cava, B, 3, gasping respiration, B, 4,

release of both venæ cavæ Respiratory curve reflected in carotid tracing C, 1, Obstruction of inferior vena cava, C, 2, obstruction of superior vena cava, C, 3, gasping respiration, C, 4, release of superior vena cava, C, 5, release of inferior vena cava

in the intratracheal anesthesia apparatus, helped a great deal in aiding recovery of respiration when the periods of obstruction were prolonged to 7, $7\frac{1}{2}$, or 9 minutes (obstruction of the venæ cavæ) Except in obstruction of the venæ cavæ, spontaneous recovery of respiratory function was much more frequent than spontaneous resumption of cardiac activity

CLINICAL APPLICATION

It was interesting to learn that the heart would continue to beat regularly for periods of 6 or 7 minutes with complete obstruction of the entrance to the right heart. The almost bloodless field during this period greatly facilitates the performance of a number of cardiac operations such as suturing of wounds, removal of foreign bodies, and production or treatment of valvular lesions. This period could be prolonged by momentarily releasing the venæ cavæ and allowing a little blood to flow into the heart substantiating the results of Nystroem and Blalock. This blood probably irrigates the coronary circulation, thus strengthening the cardiac muscle. By this technique a recovery was obtained after a period of 9 minutes' obstruction in one dog and $7\frac{1}{2}$ minutes in another (Fig 8). Five minutes of complete obstruction was always well tolerated and was followed by spontaneous recovery.

On reviewing records of pulmonary artery and aorta obstruction together, we found no variations of the curve of the protocol given. By comparing the auricular and jugular curves one notes that the left heart does not suffer as

much as the right in this type of obstruction. Although showing an acute rise, the pressure in the left auricle rapidly decreased below its initial level, whereas the pressure in the right auricle represented by the jugular curve remained elevated. As far as the heart was concerned the occlusion of both pulmonary artery and aorta was more like obstruction of the pulmonary artery than like obstruction of the aorta. The right heart had to support the same burden as in the occlusion of the pulmonary artery whereas the left heart, in spite of the aortic occlusion did not suffer dilatation, because, as demonstrated by the left auricular tracing, less blood came from the lungs. Furthermore, it is well known that the left heart is stronger than the right. At any rate [the ill effect of occlusion of the pulmonary artery and aorta did not appear to be worse than obstruction of the pulmonary artery alone. This belief is contrary to the conclusions of Nystroem and Blalock. Thus in the operation for pulmonary embolism, if the pulmonary artery is to be occluded, including the aorta in the clamp would be tolerated just as easily by the heart. Since aortic occlusion is tolerated much better than pulmonary obstruction, a rational basis for occlusion of the aorta, alone, allowing the pulmonary artery to bleed freely, as practiced by Craaford in his later operations, is shown.

Disturbances in circulation and respiration following the interruption of the blood flow through the great vessels is not infrequently observed in clinical cases. The pres-

sure in the venæ cavæ being low any considerable alteration of the intrathoracic pressures may interfere with the return flow of blood to the heart. The air of a tension pneumothorax, the fluid of extensive empyema, a chest wall or pleural tumor in the right side may compress the venæ cavæ. The same mechanism may take place in tumors infection scars or emphysema of the mediastinum. Acute and chronic compressive heart disease prevents adequate filling of the right heart which in turn is reflected in the circulation. Thrombosis of the venæ cavæ obstructs the circulation from within. Surgery of the great vessels and of the heart has not as yet reached its final stage of advancement.

As afore mentioned, the fact that regular cardiac contractions continue during 7 minutes of obstruction of the venæ cavæ, suggests that this procedure would facilitate the performance of a number of cardiac and intra cardiac operations. In regard to pulmonary embolism, this study reveals that obstruction of one of the branches of the pulmonary artery is not accompanied by great disturbances of the arterial pressure. Furthermore, that during the Trendelenburg operation, constriction of the pulmonary artery and aorta will produce a failure of the right heart. Finally it was demonstrated that obstruction of the circulation through the venæ cavæ provided the longest safe period for the removal of pulmonary emboli during interruption of the blood flow through the heart.

SUMMARY

Obstruction of the blood flow through vessels leading to or from the heart was produced in dogs. The resultant variations in cardiovascular and respiratory physiology simulated very closely those usually associated with certain clinic conditions. Of the large blood vessels connected with the heart, obstruction of the venæ cavæ and azygos were by far the best tolerated. Cardiac activity remained regular for as long as 9 minutes with complete cessation of blood flow to the right heart. Obstruction of the pulmonary artery was tolerated the poorest of that of all the great vessels of the heart, presumably because of the opposite factor that is, in venæ caval obstruction the cardiac muscle is put somewhat at rest whereas in obstruction of the pulmonary artery the right heart burden is greatly increased. The practical application of these findings to clinical problems in thoracic surgery is discussed.

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THE EFFECT OF PROLONGED LOCAL ANESTHESIA IN OIL ON ABDOMINAL WOUND HEALING

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THE use of prolonged anesthesia in oil in abdominal operations seems logical in the light of our clinical experience with this type of anesthesia in other locations. This would seem to be particularly useful in operations involving the upper abdomen, in which it would be most advantageous to reduce or eliminate incisional pain, prevent abdominal wall and diaphragmatic splinting, and thus lower the incidence of pulmonary complications as a result of more normal respiratory excursions. This problem is now being investigated further by one of us (J A G).

A careful search of the literature fails to reveal any reference to the previous application of prolonged anesthesia in oil to abdominal incisions. In an effort to determine the feasibility of the use of this type of anesthesia in abdominal surgery we devised animal experiments to simulate, as closely as possible, operative conditions in the human subject. We used the incisions and suture materials commonly employed, together with the local anesthetic in oil which we have found to be superior to others commonly used.

CLINICAL APPLICATION AND CHOICE OF LOCAL ANESTHESIA IN OIL

In the Vanderbilt Clinic, Presbyterian Hospital, and in the senior author's private practice, we have operated upon 429 entirely ambulatory patients, who were suffering from local anal disease and infected pilonidal sinuses, under infiltration anesthesia in oil without any preliminary medication. We have injected this type of anesthetic material subcutaneously several times for widely distributed facial pruritus, intercostal neuralgia, and

peripheral cervical neuritis without any untoward effects.

One of us (C V B) is now carrying on experiments to determine the usefulness of this type of anesthetic in nerve block and spinal anesthetics. We have used all of the better known anesthetics in oil, and have had infection or necrosis of clinical significance in 2 of our anal cases in the presence of new preparations of oil anesthesia or an incidence of 0.004 per cent, and no infection or necrosis in our 427 other cases in which our regular anesthetics in oil were used. This incidence includes the use of all of the better known oil anesthetics and involves those patients cared for during the development of our present very satisfactory technique.

For more than 4 years we have used neothiol and with this preparation have had no infection or necrosis. We have experienced almost none of the redness and induration which not infrequently accompanies the administration of the other preparations. Neothiol has been so satisfactory in our hands that we have used it exclusively in our experiments.

Animals Cats, weighing on an average of 3.95 kilograms were selected for the experimental work. A total of 20 animals was used.

General anesthesia During the early experiments the cats were anesthetized by the intraperitoneal injection of nembutal, 30 milligrams per kilogram of body weight in normal saline. Two animals died of what seemed to be nembutal intoxication. Following this, we used ether inhalation anesthesia in all operations and biopsies.

Preparation of the skin The operative area was shaved, washed with ether and alcohol, then painted with a 3½ per cent tincture of iodine, which was removed with 95 per cent alcohol.

From the Department of Surgery, Presbyterian Hospital and the Laboratory of Surgical Pathology, College of Physicians and Surgeons, Columbia University.

TABLE 1—CLEAN AND DISCHARGING WOUNDS

Local infiltration	No. of wounds	Silk closures		Catgut closures	
		Clean	Discharging	Clean	Discharging
No. oil—(control)	8				
Plain oil					
Neotheseol in oil	18				7
Total	26	9	6	3	

Incisions and controls. Transverse and muscle splitting, upper and lower rectus incisions 7 centimeters long were made through the entire abdominal wall including the peritoneum. The experiments were controlled by making some incisions without local infiltration, others after the infiltration of plain sterile almond oil, which is the base of the anesthetic, and still others after the local anesthetic, neotheseol, was injected into all layers of the abdominal wall.

Thirty primary abdominal incisions and 56 biopsy excisions of parts of the abdominal wall were made on a total of 20 animals. Three of these primary incisions were upper transverse, 17 upper split rectus, and 10 were lower split rectus incisions.

Intra oral infiltration of anesthetic in oil. In 4 instances 3 cubic centimeters of neotheseol was injected into the submucosal spaces of the cheeks of the cats. The infiltration extended from the angle of the mouth to the base of the tongue. This represented an exceedingly large amount of anesthetic in oil for the small space into which it was injected. Frequent inspections of these areas and the microscopic studies on the tissue removed showed no inflammatory reaction. This suggests the possibility of the use of this type of anesthetic in tonsillectomies and particularly in dental and other specific nerve blocks.

Technique of injection of plain or anesthetic oil. Three or 4 cubic centimeters of the material desired was injected throughout the thickness of the abdominal wall so that about 1.5 cubic centimeters was deposited in the subcutaneous tissue 1.5 cubic centimeters into the muscle layer beneath the fascia, and 1 cubic centimeter into the peritoneal layer. This represents far more oil or anesthetic material per kilogram of body weight

per cat than would be used in a human subject.

The incision was made immediately through this line of injection, and usually some of the oil was seen to escape from the incised tissue.

Suture material. Fine silk and catgut sutures were used in closing all types of incisions, that is, in the controls, without any local injection, as well as those with plain oil and with anesthetic oil. Both continuous and interrupted sutures were used in all combinations with little or no difference in the effect. Catgut and silk were not combined in the depth of any wound, although silk was used to close the skin in all instances.

In 15 incisions fine silk sutures were used throughout. In 15 other incisions plain No. 00 catgut was used in the peritoneum, chromic No. 00 in the fascia, and interrupted fine silk in the skin. Silk was used in 5 control incisions without any local injection of plain or anesthetic oil in 2 instances where plain oil was injected and 8 times in the presence of anesthetic oil.

Catgut was employed in 3 control incisions without plain or anesthetic oil, twice in the presence of plain oil and 10 times following injection of anesthetic oil.

These 30 incisions, including 8 controls, provide a fair distribution of controls and possible combinations of plain and anesthetic oils and suture materials of silk and catgut (Table I).

Clinical interpretation of results. The interpretation is on the basis of clean wounds as opposed to those from which there was observed any discharge at any time. Cultures were not taken and, therefore we cannot use the term infected.

Of the 15 wounds closed with silk, 5 were controls, without any oil or other local injections, 1 or 20 per cent of which remained clean and 4 or 80 per cent showed discharge. Two were injected with plain, sterile almond oil, 1 or 50 per cent of which remained clean, and the other showed discharge. Eight were infiltrated with neotheseol 7 or 87½ per cent of which remained clean and 1 or 12½ per cent showed discharge.

Of the 5 wounds closed with catgut, the 3 or 100 per cent without any local injection and the 2 or 100 per cent with plain oil in the



Fig 1 Abdominal wound, silk closure, no oil infiltration, 3 weeks after operation Wound healing, A, is good, there is practically no reaction about the silk sutures, B Breast tissue, D, is seen in the subcutaneous area $\times 9$

incision showed discharge, and 3 or 30 per cent remained clean

Thus, out of a total of 15 incisions closed with catgut, 12 or 80 per cent presented discharge, while of 15 incisions closed with silk, 6 or 40 per cent showed discharge

In the vast majority of the silk wounds the discharge was slight and was confined usually to a small part of the incision Skin necrosis, due to pressure from sutures, was by far the commonest factor in accounting for the discharge

In the wounds closed with catgut the discharge was more profuse, and frequently a part of the wound broke down The presence of catgut, even in the controls without local injection, always signaled the outpouring of discharge, in contrast to the far less frequent discharge in the presence of silk

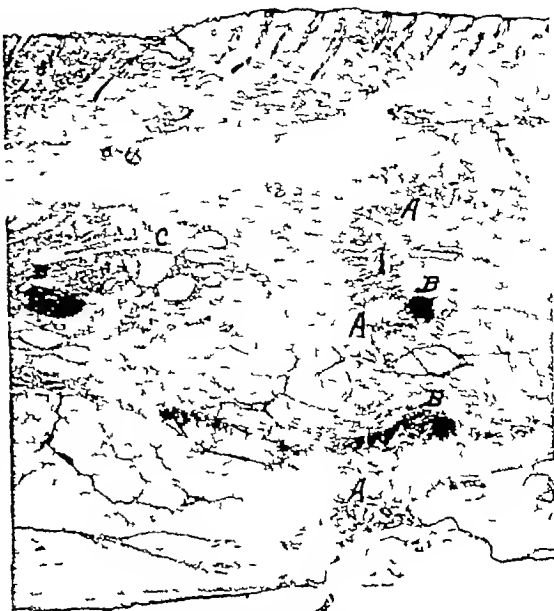


Fig 2 Abdominal wound, silk closure, almond oil infiltration, 2 weeks after operation Wound, A, which shows good healing, extends through the entire specimen Silk sutures, B, and oil spaces, C, in the center of the field show relatively little surrounding reaction $\times 9$

Résumé of results In view of the very high incidence of discharge, 80 per cent, from all wounds sutured with catgut, we must consider this form of suture material undesirable in the cat However, in wounds sutured with silk, the 40 per cent incidence of discharge was much lower, and most of those showing discharge were control cases Inspection of Table I shows that in the wounds containing anesthesia in oil, sutured with silk, there was discharge in 1 or 12½ per cent, which is by far the best combination in our series The wounds sutured with catgut in the presence of anesthetic oil showed a discharge in 7 or 70 per cent of the cases, which is better than in the control series, all 5 or 100 per cent showed discharge, including 3 without any local and 2 with plain oil infiltration

Biopsy of wounds Sections were taken through all layers of the abdominal wounds which had healed *per primam*, at intervals of 1 and 2 weeks, and usually at 4 weeks or later following the initial incision, in order to obtain material for study at varying periods in the healing process In those cases showing



Fig. 3 Abdominal wound, silk closure—absent oil infiltration, 7 weeks after operation. Practically no reaction is present about the oil spaces, C. There is slight acellular area of reaction about the silk suture B. $\times 5$.

marked reaction or discharge operative procedures were deferred until these manifestations had cleared up and the wound was firmly healed.

In order to get representative sections the first 2 biopsies were taken near the extremities of the wound transversely to the initial incision but well within the originally incised area, and the third was taken through the



Fig. 5 Abdominal wound, silk closure; anesthesia in oil infiltration, 7 weeks after operation. Compare absence of reaction around the oil spaces, C, with Figure 3 (plain oil). Slight reaction is seen around the silk suture B as in Figure 3. $\times 13$.

center. It is conceivable that the reaction about a previous biopsy wound could affect the histological picture of the original incision. However on the whole, it was felt that representative sections were obtained in this manner.

MICROSCOPIC STUDY OF THE SECTIONS THROUGH THE ABDOMINAL WOUNDS

1. *Silk closure—no oil* (Fig. 1) A small dip or thickening of the epithelium is usually present at the site of the scar. Beneath this the scar tissue can be seen extending through all layers, including the peritoneum. Early the fibroblasts appear large and frequently are multinucleated. A varying degree of leucocytic infiltration composed of polymorphonuclears, lymphocytes and sometimes eosinophiles and plasma cells, is present. Multinucleated foreign body giant cells are sometimes seen in small numbers. The granulation tissue is permeated by many capillaries, and in some areas organization of previous areas of hemorrhage is found. Later the cellular reaction has largely disappeared and the cicatrix is composed of rather densely organized fibrous tissue.

The silk sutures and ligatures are found in the deeper portions of the wound and are



Fig. 4 Abdominal wound, silk closure—absent oil infiltration, 7 weeks after operation. The scar A through the skin, subcutaneous and muscle layers shows good healing; large numbers of oil spaces, C, are seen in the subcutaneous tissue and the silk sutures, B, are visible in the muscle layer. Breast cancer D is present in the left side of the field. $\times 7$.

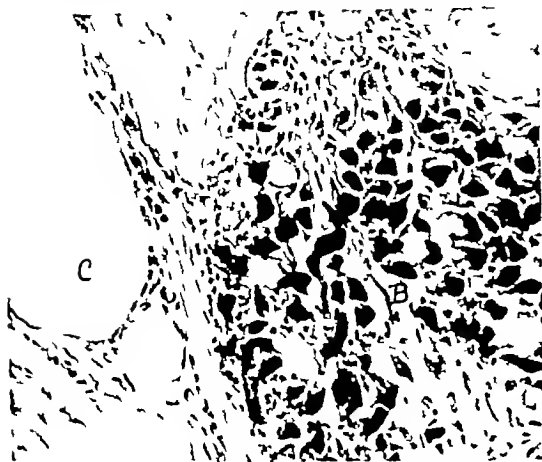


Fig 6 Abdominal wound, silk closure, anesthesia in oil infiltration, 2 weeks after operation. Silk fibers, *B*, are separated by granulation tissue and inflammatory cells, many multinucleated giant cells are present, large oil space, *C*, adjacent to the silk sutures shows no peripheral reaction $\times 115$



Fig 7 Abdominal wound, silk closure, anesthesia in oil infiltration, 10 weeks after operation. Scar tissue, *A*, is firm, only a few small oil spaces, *C*, remain in the sub peritoneal tissue $\times 25$

arranged usually on either side of the cicatrix. The entire suture as well as the individual fibers are surrounded by a minimal exudate and inflammatory reaction. This reaction varies considerably in different locations and at different stages in the healing process. It is usually slight, however, and is soon replaced by actual infiltration and ingrowth of fibroblasts, so that ultimately there is a thickening of tissue about the periphery of the suture material as well as a network of fibrous tissue between the individual strands. In many instances the zone adjacent to the scar shows relatively little fibroplasia, while the opposite side shows a rather wide semilunar area of fibrosis, which is apparently the result of proliferation of tissue, which resulted in the obliteration of the dead space created by pressure of the suture on the tissue as illustrated in Figure 3.

2 *Silk closure—almond oil infiltration* (Fig 2). These wounds show essentially the same picture as that just described with the addition of multiple round or ovoid spaces scattered throughout the tissue and varying considerably in size. It is obvious that these vacuoles represent the loculi in which oil was retained before section of the tissue. These areas are devoid of cellular exudate or debris,

and are surrounded by a syncytial lining layer usually 1 or 2 cells in thickness. Rarely are polymorphonuclear cells found, and no evidence of tissue necrosis has been noted. In many areas numerous spaces are grouped together, and the scant surrounding tissue forms a syncytium.

Healing progresses in the usual manner, and no apparent interference with wound healing, due to the presence of the oil, is noted (Fig 3). The reaction about the silk sutures is quantitatively and qualitatively about the same as in the wounds without oil.

3 *Silk closure—anesthesia in oil infiltration* (Fig 4). Wound healing appears to progress in a normal manner. There is no discernible difference in the reaction about the oil in these sections as compared to the almond oil controls. The reaction is very slight and seems to be controlled somewhat by the amount of oil and the pressure with which it has been injected rather than by factors intrinsic to the oil. When excessive amounts are introduced under great pressure, the reaction is correspondingly more marked.

The reaction about the silk sutures is not altered by the presence of oil (Figs 5 and 6).



Fig. 8. Abdominal wound catgut closure—no oil infiltration, 3 weeks after operation. The round marker indicates the site of small fragment of catgut, *F* remaining in the subperitoneal tissue; the scar *A* is seen through the subcutaneous and muscle layers; the granulation tissue and edema, *B*, are seen adjacent to the muscle layer; adipose and breast tissue *D* are at the left. $\times 7$

This process seems to depend entirely upon factors intrinsic to the silk and the manner in which the silk has been placed in the tissue.

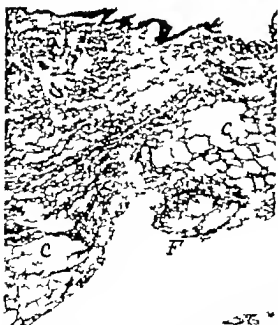


Fig. 9. Abdominal wound catgut closure—anesthetic oil infiltration, 3 weeks after operation. There is some fragmentation of the catgut suture, *F*; almost no reaction is seen about the oil, *C*, which is in excess in the subcutaneous tissue. $\times 33$



Fig. 10. Abdominal wound catgut closure—almost oil infiltration, 7 weeks after operation. There is marked cat ret, *F* absorption, and some residual oil spaces, *C*. $\times 33$

The oil appears to accumulate largely in the subcutaneous and peritoneal areas, while that injected into the muscle seems to be absorbed earlier. Multiple small spaces are seen in the muscle in the early sections, while practically none can be found in the late sections. At 10 weeks (Fig. 7) the only evidence of oil is found in the peritoneal tissues and here no particular reaction or tendency to adhesion formation can be made out.

4. *Catgut closure—no oil* (Fig. 8). The sections show essentially the same picture of wound healing as was described for the silk wound except for the fact that there are considerably more edema and inflammatory reaction through the cicatrix and about the suture material. Many polymorphonuclear cells are present early especially throughout the granulation tissue and about the catgut sutures. Fibroblastic proliferation seems to progress actively and the cicatrix appears to be quite firm at the end of 2 weeks. During this period the catgut sutures, which appear initially as single strands, usually become swollen and fragmented. Inflammatory cells infiltrate the spaces between the strands, and an irregular absorption occurs, which gives the appearance of a scalloped margin in cross

section In many sections digestion of the catgut is far advanced within 3 or 4 weeks, while in others relatively little change is observed In all, however, a relatively more marked inflammatory reaction about the periphery is noted than in the wounds closed with silk sutures In the sections taken late, the polymorphonuclear cells have disintegrated, and a dense network of fibrous tissue, containing giant and plasma cells, is present

5 *Catgut closure—almond oil infiltration* (Fig 9) There is evidence of fairly good wound healing, in spite of quite marked inflammatory reaction about the catgut, which is digested at approximately the same rate as in the control sections without oil There appears to be no relationship between the reaction about the catgut and the presence of oil In many areas oil spaces are seen adjacent to a catgut suture, and frequently there is an intense reaction about the suture material, while the usual single layer of lymphocytes and fibroblasts surrounds the oil globules

6 *Catgut closure—anesthesia in oil infiltration* (Fig 10) Wound healing progresses as favorably as in the catgut control cases The inflammatory reaction in the wound and also around the catgut is of moderate degree The variation in the rate of catgut absorption is again noted (Fig 11) Here, also, the oil spaces are distributed throughout the tissue, but there is a tendency to concentration in the subcutaneous and peritoneal tissues Early the spaces are large and the reaction is slight to moderate The spaces become progressively smaller, and the mild peripheral cellular reaction decreases In a section taken at 7 weeks only a few small oil spaces and several fragments of incompletely absorbed catgut are seen The cicatrix is firm and the peritoneum is intact

SUMMARY AND CONCLUSIONS

1 Typical abdominal incisions were made into the peritoneal cavity of cats, some without any local anesthetic infiltration, others following the injection of plain almond oil locally, and others after the local infiltration of anesthesia in oil

2 Catgut and silk were used separately to close the deeper layers of all types of wounds



Fig 11 Abdominal wound, catgut closure, anesthesia in oil infiltration, 2 weeks after operation Catgut, *F*, which is sectioned longitudinally, shows fragmentation, oil spaces, *C*, in the muscle and adjacent to the catgut show no inflammatory reaction $\times 25$

3 Catgut in all these wounds caused marked local inflammatory reaction and signaled the outpouring of serum, irrespective of whether or not there was any local oil infiltration into the tissues

4 There was slight reaction in the wounds closed with silk, and this would seem to be a desirable form of suture material in the cat

5 Of 15 incisions closed with catgut, 12 or 80 per cent showed discharge

6 Of the 15 incisions closed with silk, 6 or 40 per cent presented discharge

7 In the 8 control cases, without local infiltration, 4 or 50 per cent with silk closure and 3 or 100 per cent with catgut closure showed discharge

8 In the 4 instances in which plain almond oil was infiltrated, 1 or 25 per cent closed with silk and 2 or 100 per cent with catgut closure showed discharge

9. In the 18 cases into which anesthesia in oil (neothesol) was infiltrated 1 or 12.5 per cent closed with silk and 7 or 70 per cent closed with catgut presented discharge.

10. There is no evidence to suggest that the presence of almond oil plain or anesthetic in any of the wounds increased the incidence of discharge with either type of suture material.

11. These findings indicate that anesthesia in oil or plain oil does not cause any delay in wound healing or any tendency for the wounds to break down or discharge.

12. The fact that the oil in these wounds does not show any appreciable surrounding inflammatory reaction suggests the possibility of using this type of infiltration anesthesia in human incisions.

13. The absence of gross or microscopic reaction in the cheek of the cat after a local anesthetic in oil infiltration was used suggests its use in tonsillectomies or nerve block and, possibly in spinal anesthetics. The senior author is now carrying on experiments along this line.

THYROID DISEASE IN THE SOUTHERN NEGRO

A Comparative Analysis of 470 White and 482 Negro Cases from Charity Hospital of Louisiana at New Orleans

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WHEN S A Cartwright, in 1851, made his report to the Medical Association of Louisiana on a study of the diseases and physical peculiarities of the negro, he said that negroes were so different from white persons that it would be safer for overseers, who knew no medicine but who did understand their racial peculiarities, to treat them empirically when they were ill than for the queen's own physician to attend them. To physicians and surgeons who practice in the South that statement is not altogether absurd. It contains an important truth in its implication that the manifestations of certain diseases differ in the negro and white races.

In 1887, when a group of southern physicians discussed the surgical problems of the negro before the American Surgical Association (31), they pointed out that certain surgical affections pursue different courses in the negro and in the white man under identical hygienic surroundings. The mulatto was a less good surgical risk than the pure black negro, they pointed out, but negroes as a race bore surgical injuries and operative procedures better than white men, and recovered from them more speedily, because their nervous systems were less sensitive.

In 1896, when Matas published his classical monograph entitled, "The Surgical Peculiarities of the American Negro," for almost the first time the variations in the incidence and mortality of certain diseases in the negro and white races were analyzed scientifically. Matas' source was the enormous clinical material of Charity Hospital of Louisiana at New Orleans, and racial differences in disease furnish as many problems for the surgeon of

1939 in that institution as they did for the surgeon of 1896.

One or two of the more recent studies from Charity Hospital might be mentioned to illustrate this point. Kampmeier found arteriosclerosis in 41.8 per cent of 239 consecutive negro males under 40 years of age who were being treated for other conditions and in whom hypertension, cardiac disease, and nephritis could not be demonstrated. Cutting and his associates found by means of the Kahn test an incidence of syphilis amounting to 35.5 per cent in 509 negro males who had applied for surgical treatment, the incidence rose to 49.5 per cent when less strict laboratory criteria were applied. Miller (23, 24) and others have pointed out that uterine fibroids are 9 times more frequent in negro than in white women and very much larger, and that pelvic inflammatory disease is more frequent and more extensive. In a study of 2,715 cases of acute appendicitis (3) we found that negroes furnished less than 25 per cent of the incidence but more than 40 per cent of the mortality. We (6) also found a similar though less marked disproportion between the negro incidence and mortality in 404 surgical cases of biliary tract disease.

Such figures as these seem to justify the speculation that diseases to which the negro is immune in his native environment manifest themselves with special virulence when he is transplanted elsewhere. This or some other theory is needed to explain certain phases of thyroid disease in the negro in Charity Hospital of Louisiana.

COMPARATIVE RACIAL INCIDENCE

During the 12½ year period ending July 1, 1938, 952 patients with thyroid disease were treated in this institution by 976 operations, i e.,

From the Department of Surgery of the Graduate School of Medicine Louisiana State University

TABLE I.—DISTRIBUTION OF THYROID DISEASE
IN THE NEW ORLEANS CHARITY HOSPITAL
JANUARY 1 1927 JULY 1 1938

Distribution	Cases No.	Deaths No.	Mortality per cent
Total cases	52	30	
White	470		6
Negro	482	22	4
Male	205	5	24
Female	847	21	
Non-toxic	227		
Toxic	400	26	6.5
Diffuse	476	21	
Nodular	478	27	5.6

an incidence of 1 596 in the 567 214 admissions and 1 173 in the 168,385 operations which were performed, exclusive of nose and throat operations, during the same period of time.

The white incidence (470 cases) is 1 691 in 324,969 admissions and the negro (482 cases) 1 503 in 242 245 admissions. The proportion of white to negro admissions is thus 57.2 to 42.8 but the proportion of surgical thyroid disease is 49.3 to 50.7. These figures do not represent the absolute proportionate incidence of thyroid disease in this area. The New Orleans Charity Hospital supplies the medical needs of most negroes in Louisiana as well as in New Orleans, but indigent white patients can be cared for in several other institutions as well. The figures make no provision furthermore, for patients who can pay for their medical services, although the number of these in the negro race is relatively insignificant. The negro population is 29 per cent in New Orleans, according to Association of Commerce figures, and 36.9 per cent in Louisiana.

A consideration of the figures from the standpoint of toxicity (Table I) effectually disposes of the idea, which was once very widely held, that toxic thyroid disease is rare in the negro. As a matter of fact it follows rather roughly the ratio of negro and white hospital admissions. The diffuse variety of toxic disease is more frequent than the nodular in the negro although in non toxic disease the reverse is true.

COMPARATIVE RACIAL MORTALITY

Far more striking than the variations in the incidence of thyroid disease in the two races are the disparities in mortality and particularly in the mortalities according to sex distribution (Tables I and II). The mortality for the whole series of 952 cases is 5.3 per cent, which is high even for a non-endemic area. The negroes, who furnish just over half of the incidence furnish almost two-thirds of the mortality. The total male mortality of 14.3 per cent, or 15 of 105 cases, is more than four times the female mortality of 3.5 per cent, or 33 of 847 cases. In females the negro mortality is higher than the white mortality in both varieties of non toxic disease, but the differences are not disproportionate. In both varieties of toxic disease however it is more than twice as high. In males, the negro death rate far exceeds the white in all varieties of thyroid disease and in the toxic variety it rises to shocking figures. These disparities are beyond explanation, for no argument would seem to apply to the negro male which does not apply to the negro female as well.

In both negro and white subjects the mortality for diffuse toxic disease is higher than for nodular toxic disease. This circumstance which is contrary to the usual experience is also difficult to explain since in nodular toxic disease the hazards of cardiac disease and other visceral damage are added to the inherent hazards of toxic thyroid disease.

It is interesting and perhaps significant that more than two-thirds of all the patients were treated during the last 53½ years of this study and that almost three-quarters of the negroes were treated within this period. In recent years the white mortality has shown some improvement, but the negro mortality has continued very high, which perhaps is further evidence of the inherently more serious character of this disease in the race.

As we have pointed out elsewhere (1) our figures are entirely representative of thyroid disease in this community. Less than half of the deaths from thyroid disease in New Orleans occurs in the public institution where one might reasonably expect to find most of them, though practically all of the negro deaths, for obvious reasons, occur in it. It

might be pointed out also that in the 5 year period ending in 1937 there was only 1 year in which the local death rate for toxic thyroid disease was even fractionally lower than the national rate, and in 1 year it was twice as high. During the same period the local death rate for non-toxic disease was from 2 to 8 times higher than the national rate.

COMPARISONS WITH OTHER SERIES

Very few series of cases are available for comparison with the New Orleans figures. The reports of Jones, Clifton, and Davison and Poer, from Atlanta, Drennan, from Alabama, and Street, from Mississippi, do not emphasize the racial factor. Hermann's report of 40 cases of hyperthyroidism in the negro is from a northern hospital (Lakeside) and it is doubtful whether northern negroes are comparable with southern negroes, who in many respects present a peculiar medical and economic problem. The negro in the South is chiefly dependent upon the white man for his livelihood and for his medical care, most of which is secured in public institutions. He has lower standards of living than the white man, has elementary ideas of hygiene and sex relationships, and is slow in seeking medical aid, perhaps because he is apparently less sensitive to pain and to nervous stimuli than the white man. The northern negro, on the other hand, has adapted himself to the ways of civilization and more nearly approaches the white man in his reactions.

Porter and Walker, from Richmond, Virginia, report 36 cases of hyperthyroidism in negroes, who were treated, with a mortality rate of 11.4 per cent, 2 patients died in crisis immediately after admission, and there were 4 deaths in the 34 surgical cases. During the same period 71 white patients were treated by the same staff with no deaths. These authors attribute the high negro mortality to delayed treatment rather than to inherently more serious disease. Lehman and Shearburn, from the University of Virginia Hospital, report a 9.43 per cent mortality in 53 negro patients with hyperthyroidism (6 males and 47 females) against a mortality of 0.84 per cent in 237 white patients. The mortality in both these series approaches the mortality at New

TABLE II — RACIAL AND SEX DISTRIBUTION OF THYROID DISEASE IN THE NEW ORLEANS CHARITY HOSPITAL—JANUARY 1, 1927–JULY 1, 1938

Distribution	Cases No	Deaths No	Mortality per cent
Diffuse non toxic	248	6	2.8
White male	19		
Negro male	21	4	19.0
White female	94	1	1.1
Negro female	112	2	1.8
Nodular non toxic	284	5	1.6
White male	10		
Negro male	12	2	16.6
White female	110	1	0.9
Negro female	152	2	1.3
Diffuse toxic	28	26	11.4
White male	23	4	17.4
Negro male	12	4	33.3
White female	111	7	6.3
Negro female	82	11	13.4
Nodular toxic	192	12	6.2
White male	4		
Negro male	4	1	25.0
White female	99	4	4.0
Negro female	85	7	8.2

Orleans Charity Hospital, though at the University of Virginia, contrary to our experience, all the negro deaths occurred in females.

No general survey of the incidence of thyroid disease has been made in New Orleans. In Manhattan there was a slightly lower incidence of thyroid enlargement in negro than in white school children (9). In Cincinnati the incidence was slightly higher. In Rutherford County, Tennessee, as well as in Murfreesboro, Tennessee, in a controlled study the negro incidence of thyroid enlargement was considerably higher than the white (25).

THE CYCLE OF THYROID DISEASE IN THE NEGRO

The incidence of thyroid enlargements in young negroes in the studies just quoted seem indirectly to support the contention we have made in previous communications (19–21), namely, that toxic thyroid disease in southern negroes, as is usual in endemic areas, seems to arise on the basis of a previous non-toxic dif-

fuse goiter whereas in white subjects it arises as virgin pathology. The simple type of goiter which amounts to little more than an enlargement of the neck, is fairly frequent in young negro women. We have kept a number of such patients under observation for several years, and in most instances the gland has either not increased in size or has decreased. We believe therefore that we are justified in saying that symptomless thyroid enlargements in young negro women in this community should be operated upon only after a period of observation. This type of goiter gives rise to no symptoms *per se* and in most cases no further pathological change occurs.

Although 22 negro patients in the toxic and 6 in the non toxic group dated their goiters or their thyroid symptoms to pregnancy, puberty, the menopause, an operation, an illness or a shock, we do not accept the histories at their face value. In previous communications we have called attention to the tendency of negroes to exaggerate their miseries and to furnish any symptoms expected of them, and that tendency undoubtedly explains why certain patients attributed their illnesses to special circumstances or facts. Negroes are phlegmatic they take life as it comes, their emotions are superficial and noisy rather than deep-seated and essential, and the negro woman who according to her own story developed her goiter after she had "boiled" two days twenty years ago when her mother died is quite typical of the race.

In some negroes, however, whatever the reason or whatever the special strain upon the organism which fans the gland into activity, the inactive gland is stimulated and the toxic diffuse stage is reached. The white patient is likely to prevent himself for treatment at this stage, the negro is not perhaps because his sensibilities are less keen, his toxic manifestations less marked or perhaps because thyroid disease is not associated with pain, which is the negro's chief reason for seeking medical attention. Any one of these explanations or all of them may account for the fact that toxic diffuse goiter formed 19.5 per cent or 94 of 482 cases of the negro incidence against 28.5 per cent, or 134 of 470 cases, of the white incidence.

In the natural cycle the diffuse toxic stage wears itself out and the gland passes over into the non-toxic stage. Whether or not toxic manifestations reappear depends upon whether or not the stimuli, known or unknown, which were responsible for the original activity again become effective. This cycle of events, in our opinion, accounts for the fact that non-toxic nodular goiter formed 34.0 per cent of all the negro cases, or 164 of 482 cases, against 25.5 per cent of the white, or 120 of 470 cases.

It is quite possible that in some instances the gland may return to the original colloid or resting state, by the working of the law that all thyroid disease eventually burns itself out if it does not first burn out the patient. This surmise is supported by the fact that there were 45 cases of diffuse non-toxic goiter in negroes over 40 years of age against 22 cases, less than half that number in the whites.

POSSIBLE EXPLANATIONS OF THE NEGRO DEATH RATE

Such speculative reasoning explains the difference in the incidence of the various types of thyroid disease in the negro and white races, but does not explain the differences in the mortality. In this community no single surgeon sees enough cases of thyroid disease to permit him to become really familiar with the condition, and to that lack of experience part of the general mortality can be attributed. The 976 operations on the 952 patients were performed by 68 surgeons, 1 of whom performed 106 operations, incidentally with only 1 death, in a negro while another performed 63 operations with 4 deaths. At the other end of the list 6 surgeons operated on 2 patients each and 9 on 1 patient each. But such an explanation does not explain the difference in the white and negro mortalities. Fifty-four surgeons operated upon the white and 50 on the negro patients, 37 operated upon patients of both races. When the same men operated on both colored and white patients the surgeon's mortality was almost invariably higher in the negro wards.

Part of the negro mortality is undoubtedly to be attributed to the inadequate and over

crowded negro hospital facilities. It is not unusual, and often a necessity, for very ill patients to be kept 2 in a bed. Isolation and quiet are practically impossible, the negro fundamentally is unwilling to be alone. Within the last 2 years, during which the old hospital was torn down and the new one erected, the negro facilities have been particularly inadequate and the noise and confusion have had a deleterious effect particularly upon toxic thyroid patients. In at least 4 negro cases, of which I have personal knowledge, the unpropitious hospital environment played a definite part in the fatal outcome. The new hospital will shortly be occupied, and it will be interesting to see whether improved facilities will improve the negro mortality.

Part of the negro mortality can be explained by the racial tendency to delay medical consultation. As a result, the goiters are large and adherent, are often substernal, and the resultant tracheal distortion causes serious respiratory difficulties at operation. There were 69 substernal glands among the negro subjects, as compared with only 32 in the white, and most of the deaths from respiratory collapse occurred in negroes with large goiters. Adequate exposure of the glands is often difficult in negroes. Because of their habit of carrying large bundles on their heads and the fact that so many of them perform hard physical labor, their neck muscles are highly developed. This is a minor technical difficulty, however, which usually can be eliminated if the strap muscles are cut.

We personally have no doubt that although negroes develop toxicity less often than white subjects in this community, they develop it to a more intense degree. When iodine is administered properly, as it very often is not, there seems no particular difference in the negro and white response in most cases. Negroes are not as likely to have taken iodine before admission as white patients, because they are less likely to have had previous medical attention. In this series 43 white patients with toxic disease and 19 with non-toxic disease had taken iodine, against 25 toxic and 12 non-toxic negro patients. One negro, however, had ordered iodine from a mail order catalogue and had taken it for 10 years.

Fifty-one negroes, according to the histories, had exophthalmos, against 25 white patients, but again we do not accept the negro figures unreservedly, for many of them have "pop" eyes from birth. The negro response to toxicity, as measured by temperature, pulse, respiration, and basal metabolic rate does not differ materially from the white response.

There is no doubt, however, regardless of these similarities, that the negro patient is frequently more toxic than the white patient, though his toxicity is by no means as evident. As a result, the seriousness of his disease is underestimated, and either preparation is inadequate or too much surgery is done. Several negro cases in this series, too, excellently illustrate the point made by Lehman and Shearburn, that it is unwise to defer operation too long, for the optimal time for it is past often before one realizes it. That 9 of the 31 negroes in whom stage surgery was attempted or completed lost their lives, against 3 of 31 white patients, seems to suggest again that toxic thyroid disease is more serious in the negro than in the white subject.

CAUSES OF DEATH

In toxic diffuse thyroid disease 6 of the white and 9 of the negro deaths were due to crisis, 3 of the white and 1 of the negro to cardiac disease, and 2 of the white and 2 of the negro deaths to pneumonia. One negro died of respiratory collapse, 1 under the anesthetic, and 1 after a Naffziger operation for progressive exophthalmos. The last patient, a negro girl 6 years old, although exceedingly toxic, had weathered 2 lobectomies successfully.

In nodular toxic disease all 4 white deaths were due to crisis. Two negro deaths were due to crisis, 2 to respiratory failure, and 3 to cardiac disease. From July 1, 1938, when this study ended, until March 15, 1939, 2 other surgical deaths from toxic thyroid disease occurred in Charity Hospital, both in negroes, 1 patient died on the table and another died in crisis shortly after lobectomy.

In diffuse non-toxic thyroid disease 1 white patient and 1 negro died of hemorrhage. Two negro deaths were due to pneumonia, and 1 each to shock, respiratory collapse, and

TABLE III—LIVER FUNCTION (IN TERMS OF NORMAL) IN 130 CASES OF THYROID DISEASE STUDIED BY THE QUICK TEST

Type	Pre-operative serum (days)		Post-operative (days)			
		%				
White diffuse	84		76	69.7	91	99.8
Negro diffuse	79			6.1	95	8
White diffuse toxic	6	91.8		28	70	8
Negro diffuse toxic	46.5	77	76		86	88.8
White nodular	85		6.1	78	6.1	8.1
Negro nodular	8	96.6	8	76	6.1	8.1
White nodular toxic		90	75.8		6.1	87
Negro nodular toxic	27.6	79	71	86.5	54	77
Negro nodular**	66	766	100.6	130	100	77
Negro nodular toxic**	76	85	1.5	8	1.5	66.9

*After preparation.
**Prepared with oral decalin, treated passively with oral decalin and intravenous glucose.

*Note the abrupt decrease in function on the second and third days, when the supportive therapy is withdrawn.

a persistent thymus gland. In nodular non toxic disease 1 white patient and 1 negro died of hemorrhage. The 3 other negro deaths were due respectively to cardiac disease, respiratory collapse, and pneumonia. Between July 1 1938 and March 15 1939 2 other surgical deaths from non toxic thyroid disease occurred in Charity Hospital, both in negroes and both due to respiratory collapse.

During the period under discussion 21 negroes died from toxic thyroid disease with out surgery 18 from crisis, against 18 white patients, 15 of whom died from crisis. From July 1 1938 to March 15 1939, 9 other non surgical deaths have occurred 8 of which were in negroes and 5 of which were caused by crisis. The fact that 39 of the 49 non-surgical deaths occurred within the last 5 years is not the least disturbing feature of the situation. Some of the negroes entered the hospital in crisis, and 1 or 2 were practically moribund but in other cases death occurred because the intensity of the toxicity was not realized because medical treatment was continued too long or because the optimal time for surgery was permitted to pass. All these figures furnish convincing proof of the serious character of both non-toxic and toxic thyroid disease in the negro.

THE LIVER FACTOR IN THYROID DISEASE

Within the last 2 years of this study the Quick (28 29) hippuric acid test of liver function was performed on 130 patients, 85 of whom were negroes. Increasing experience has confirmed our earlier observation that in all varieties of thyroid disease the negro liver function is lower than the white (Table III). We (2 4) have suggested elsewhere that the decreased function in non-toxic disease which is evident in both negro and white subjects, although more marked in the negro may be evidence of a latent toxicity thus bearing out Hertzer's contention that no goiter is truly innocent.

The decreased hepatic function in the negro is easily explained by his tendency to ignore his symptoms and to permit his disease to progress. It is further explained if our theory be correct, by the inherently more serious character of thyroid disease in the southern negro. Whatever the reason the decrease in liver function probably explains part of the very high negro mortality. On the other hand proper preparation will in most cases overcome the visceral damage. Most negro patients respond well to such simple measures as glucose and decalin by mouth (Table III) and it is my personal practice to employ these measures routinely even in non toxic cases, to overcome the fall in liver function which follows all operations (5). Such a fall, if the initial liver function is low may readily progress beyond the lower limit of safety.

ETIOLOGY

We have unfortunately no data to explain the etiology of goiter in the negro. Webster and others have called attention to the goitrogenic properties of cabbage which, with salt meat, is a favorite diet of negroes in this community. The dietary factor may play some part in the prevalence of simple goiter but it does not, of course explain toxicity. The soil of Louisiana has been proved to be rich in iodine, and the urinary iodine studies from Tulane University which Curtis quotes in comparison with his own substantiate the amounts available. In central Ohio the average daily normal urinary excretion of iodine was 51 milligrams as compared with 177

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milligrams in New Orleans. Further studies along these and other lines seem indicated to explain the manifestations of goiter in the southern negro.

SUMMARY

1. An analysis of 952 cases of thyroid disease from Charity Hospital in New Orleans reveals a negro mortality almost twice as high as the white mortality. The disparity was particularly marked in both varieties of toxic disease and in negro males.

2. No explanation of the high negro mortality is entirely satisfactory and the speculation is advanced that the disease is actually more serious in the negro than it is in the white patient. The white mortality has shown considerable improvement in recent years but the negro mortality remains at a high level.

3. In the negro, toxic thyroid disease seems to arise on the basis of a previous simple goiter, although in the white patient in this community it seems to arise as virgin pathology.

4. The decrease in liver function in negroes in all varieties of thyroid disease seems to support the idea that the disease is inherently more serious in this race.

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THE EFFECTS OF EUPAVERINE ON THE PULMONARY CIRCULATION

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DURING the past few years occasional articles have appeared in the literature describing the use of eupaverine in the treatment of peripheral and pulmonary emboli. In 1930 Wolfes and Kreitmair published an account of their studies on this drug, a synthetic preparation closely related chemically and pharmacologically to papaverine. Other reports on the clinical and experimental use of this drug have appeared since. A brief review of the literature and personal experimental observations are presented in this paper.

Eupaverine is 1-(3,4-methylene-dioxybenzyl)-(3-methyl-6,7-methylene dioxyisoquinoline). It is a white crystalline compound which melts at 140 degrees C without decomposition. It is a weak base whose salts are decomposed by alkaline bicarbonates. The bisulphate dissolves readily in hot water.

The pharmacological effects of eupaverine are similar to those of papaverine. Saman and Wolfes and Kreitmair found it to be half as toxic as papaverine. Saman found eupaverine to be twice as active as papaverine while Wolfes and Kreitmair found it 25 per cent more potent than papaverine.

Pal first demonstrated that papaverine had a paralyzing effect on smooth muscle fibers. He showed this effect when the drug was used alone and also when it was used after muscular spasm had been induced by epinephrine. Saman found that 3 to 4 milligrams per kilogram caused a slight fall in blood pressure in experimental animals. The fall was proportionately greater with larger doses of the drug. The heart rate was increased with the larger doses. This increase in cardiac rate was abolished by a prior injection of atropine. Lethal doses caused cessation of respiration before the failure of heart action. In isolated

hearts the drug slowed the heart rate and decreased the cardiac output. These effects were not influenced by atropine showing that eupaverine acts directly on the muscle and not through the vagus or sympathetic nerves. Saman also found that eupaverine acted directly on intestinal muscle relieving spasm whether mediated through nerve muscle or both, in contrast to atropine which had no effect on direct muscle spasm.

Observations. It has been demonstrated repeatedly that after the lodging of an embolus in an artery the vessel distal to the embolized area goes into spasm. Hoping to overcome the effects of this spasm clinicians have used both papaverine and eupaverine in the treatment of arterial emboli. Kohlmeier reported several cases with peripheral arterial emboli in which striking improvement followed the use of eupaverine. Allen and MacLean observed a case of femoral embolus in which the circulation suddenly returned following the administration of papaverine.

Denk believed that the factor of spasm played an important part in the symptomatology of pulmonary embolism. In 1936 he reported 9 cases of pulmonary embolism treated with eupaverine. Seven of these recovered. He also reported 15 cases of peripheral arterial embolism treated with eupaverine, of which 17 recovered, 3 were improved and 5 were not improved. In 1937 Domanig discussed the rationale behind the use of eupaverine in pulmonary embolism. He believed that the effects of pulmonary emboli could not be explained solely on the basis of mechanical occlusion of the pulmonary vessels but that vasoospastic impulses, mediated through pulmonary vasoconstrictors, were set up by the presence of an embolus and that the resulting pulmonary arterial spasm was largely responsible for the symptoms produced. On this basis he advo-

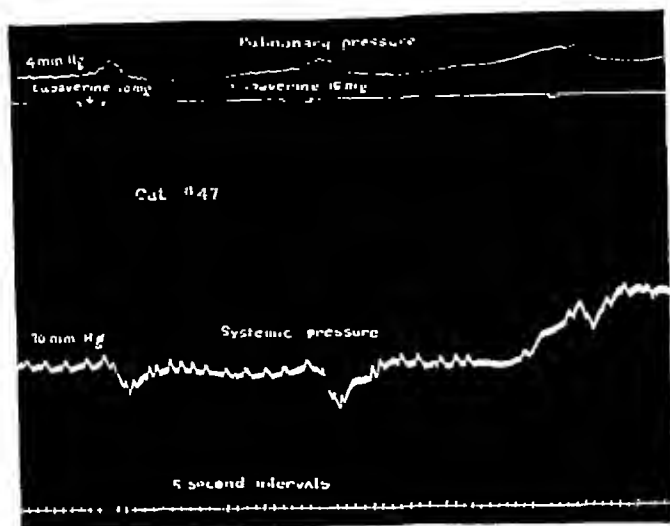


Fig 1 Effects of eupaverine on pulmonary and systemic blood pressures

cated the use of the drug in pulmonary embolism

It is generally agreed that eupaverine has a spasmolytic effect. This is evidenced in the circulatory system by a fall in blood pressure. It is difficult to understand how a generalized fall in blood pressure can benefit the part distal to an embolus, in which the arterial pressure has already been reduced to a dangerously low level by the occluding embolus. German observers have spoken rather freely of spasm in the pulmonary arterial circuit. However, a thorough review of the literature on the pulmonary autonomic nervous system leads one to the conclusion that such a system, if present, is weak in its action.

The treatment of patients suffering from pulmonary embolism is unsatisfactory. No one knows what percentage of these patients will recover spontaneously. Embolectomy occasionally has been performed successfully in the Scandinavian countries but so far no successful case has been reported in the United States. The size and position of the embolus probably has much to do with the outcome. The so called "rider" embolus projecting into both main branches of the pulmonary artery is rapidly fatal unless immediate embolectomy is done. Smaller emboli lodging in branches of the pulmonary artery are not necessarily fatal, even though branches

of both right and left pulmonary arteries may be involved. Operation in some of these latter cases may substitute a fatality for a spontaneous recovery.

Experimental studies on the effects of eupaverine have been meager, especially in the United States. It, therefore, seemed desirable

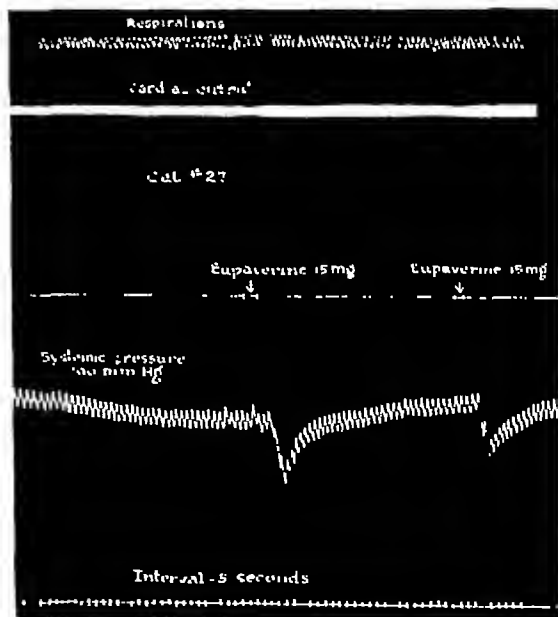


Fig 2 Effects of eupaverine on respirations, cardiac output, and systemic blood pressure



Fig. 3. Effects of Epiolol, followed by eupaverine on respiration, pulmonary and systemic blood pressures.

to make certain observations of the effects of eupaverine in normal animals and on animals with artificially induced pulmonary emboli.

Method and procedures. Cats of 3 kilogram average weight, anesthetized by the intra-peritoneal injection of 6 cubic centimeters of a 1 to 10 sodium barbital solution per kilogram were used in all experiments. The animals were prepared according to the method of Drinker in which the anterior chest plate is removed, the pericardium opened and sutured to the chest wall, thus allowing the lungs to function normally in a closed pleural cavity and permitting free access to the heart and great vessels. Recordings were made of pulmonary arterial blood pressure, systemic blood pressure, cardiac output, and respiratory rate and volume. Systemic blood pressure was recorded directly on a mercury manometer connected to a cannula in the carotid artery. Pulmonary arterial pressure was recorded directly on a mercury manometer connected to a specially devised cannula in the main trunk of the pulmonary artery. Respirations were recorded through a simple chest respirometer giving frequency and comparative amplitude of respirations. Changes

in cardiac output were determined by the use of a bell cardiometer. The soluble bisulfate of eupaverine was the drug used. An average dose of 3 milligrams per kilogram was used.

Twenty-nine animals were used in this series of experiments. Pulmonary pressure was recorded in 24, systemic pressure in all respirations in 14 and cardiac output in 8. Artificial pulmonary emboli were produced in 24 animals by the intravenous injection of sterile mineral oil and the effects of eupaverine, both before and after emboli were induced, were studied in 15.

1. EFFECTS OF OIL EMBOLI ON PULMONARY AND SYSTEMIC PRESSURES, RESPIRATIONS AND CARDIAC OUTPUT

The average pulmonary arterial pressure at the start of the experiments was 12.5 millimeters of mercury and the average systemic arterial pressure was 94.5.

It was found that an injection of oil of 1 to 2 cubic centimeters permitted survival of the animal whereas 3 cubic centimeters usually resulted in death within a few moments. Therefore 1.5 cubic centimeters of oil was the

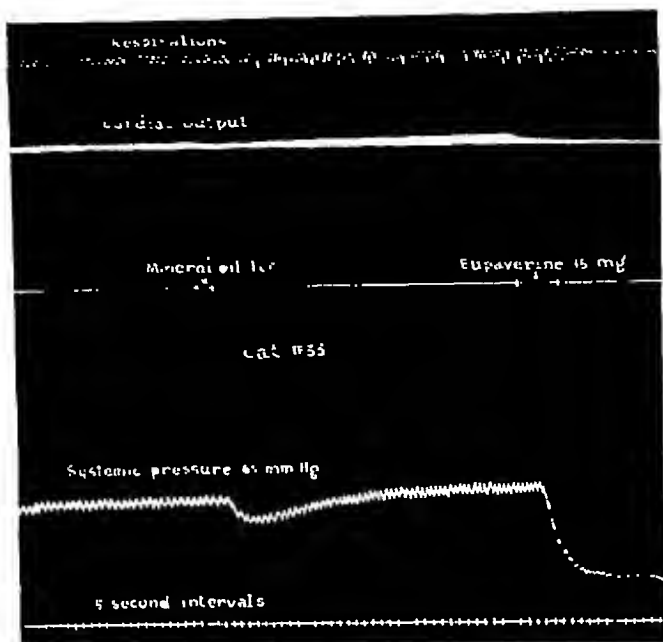


Fig 4 Effects of mineral oil followed by eupaverine on respirations, cardiac output, and systemic blood pressure

usual dose given. It was found that within 20 seconds of the injection of the oil into the femoral vein there was an average rise of pulmonary blood pressure of 28 millimeters of mercury which within 2 minutes fell to an average of 15 millimeters of mercury above the original level. At the same time there was a fall in the systemic blood pressure of 13 millimeters of mercury which then rose to a level of 8 millimeters of mercury higher than the original level.

A dose of 1.5 cubic centimeters of oil caused the respirations to increase from 19 per minute to 26 per minute. The majority of the animals showed changes in amplitude of respiration and irregularities in rate.

Cardiac output was decreased 30 per cent immediately after the intravenous injection of oil. After a few moments the cardiac output returned to 2 per cent above previous level.

2 EFFECTS OF EUPAVERINE ON PULMONARY AND SYSTEMIC PRESSURES, RESPIRATIONS, AND CARDIAC OUTPUT

After an intravenous injection of 3 milligrams of eupaverine per kilogram the pul-

monary blood pressure rose immediately in all animals, the average rise being 5.5 millimeters of mercury which in a few moments fell to 2.5 millimeters of mercury above the original level.

The systemic pressure fell immediately in all animals, the mean fall being 24 millimeters of mercury which promptly rose to 5 millimeters of mercury above the original level.

Three milligrams per kilogram of eupaverine had practically no effect on respirations except for a slight increase in amplitude.

Three milligrams of eupaverine per kilogram caused an immediate decrease in the cardiac output averaging 15 per cent of the original. This was followed shortly by an increase to a level of 6 per cent above the original.

3 EFFECTS OF EUPAVERINE ON PULMONARY AND SYSTEMIC PRESSURES, RESPIRATIONS, AND CARDIAC OUTPUT AFTER INJECTION OF OIL

When 3 milligrams of eupaverine per kilogram were given to animals after pulmonary embolization with oil there was an immediate

rise in pulmonary pressure averaging 17.5 millimeters of mercury which soon fell to a level of 8.5 millimeters of mercury above the original level.

The systemic pressure fell then fell averaged 53.5 millimeters of mercury which soon returned to a level of 13 millimeters of mercury higher than the original level.

In 3 animals the injection of eupaverine was followed immediately by a rapid fall in both pulmonary and systemic pressures and death occurred almost immediately; respirations ceased before heart action stopped.

Cardiac output decreased at an average of 40 per cent in these animals and returned to the original level in those animals that survived.

SUMMARY AND CONCLUSIONS

Eupaverine was found to have an immediate effect in lowering systemic blood pressure. This effect was extremely transient and was followed by a slight increase in the blood pressure over the original level. However in the pulmonary circuit the effect of eupaverine regularly was to cause marked increase in the blood pressure over the original level. When eupaverine was given after oil emboli the effects were qualitatively the same: increased pulmonary pressure and decreased

systemic pressure. However some of the animals failed to survive after oil followed by eupaverine. In view of these results it is difficult to understand how eupaverine could favorably influence the course of either pulmonary or systemic emboli.

Eupaverine has certain spasmolytic actions causing a marked though transient, fall in systemic blood pressure. Previous investigators have shown that this is probably due to the action directly on the smooth muscle of the vessel wall.

Eupaverine does not lower but raises, the pulmonary arterial pressure in cats.

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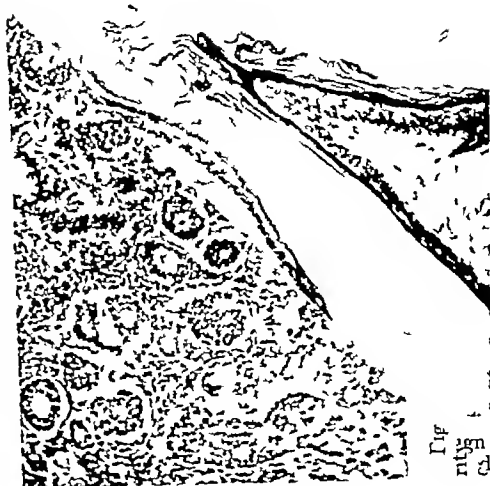
CONCEPTS OF A N OVARI

WALTER SCHIL

CLASSIFICATIONS of tumors of n
organs in the body have been es
lished, accepted, and utilized by p
ologists of the entire universe. H
ever, the classification of ovarian tumors ha
mained an unsatisfactory chapter of pathol
ever since systematic investigation started
the field of oncology. The reason for this lie
the fact that ovarian tumors, to a great
tent, consist of tissues definitely different fr
those of the normal ovary, whereas, in
other organs the structure of the tumors d
icates the normal constituents of the org
from which they arise. Thus, the muscle g
origin to the myoma, the fibrous tissue to the
fibroma, the nervous tissue to the neuroma,
etc. The classification of such tumors (myoma,
fibroma, neuroma, etc.) becomes a matter of
fact, since the analogy of such a tumor and
the normal tissue permits directly the tracing
back to the tissue from which the tumor origi
nated. On the other hand, the ovary is a
playground or a resting place for a variety of
tumors consisting of tissue elements which are
normally not found in the ovary. Such tumors
in the scientific terminology are characterized
as heterologic, or better, as heterotopic. Prior
to 15 or 20 years ago, there was no possibility
of giving a satisfactory explanation for the
origin of most of these tumors. Since the his
togenesis of ovarian tumors was not known, a
histogenetic classification was impossible. Con
sequently, the purely morphological and in
some cases the histogenetic system of classi
fication which was available and utilized for
the tumors of other organs did not exist for
those of the ovary. Substitutions for this type
of classification were made by vague clinical
or physiological conceptions, with the result
that each pathologist had his own classifica
tion and there existed no generally accepted

Presented before the 39th annual meeting of the American
Association of Pathologists and Bacteriologists in Richmond
Virginia April 1939

SURGERY, GYNECO



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the best then obtainable. Approximately 20
years later, when pathologists and gynec
ologists again attempted to give a complete
survey of ovarian tumors, they faced the great
difficulty of placing into Pfannenstiel's system
the variety of ovarian tumors which had been
discovered and investigated since Pfannen
stiel's time. The ovarian tumors had been thor
oughly investigated from the clinical and
morphological points of view but the histo
genesis of most of them was still unknown,
consequently, a histogenetic classification
could not be established.

Most of the existing presentations lack the
unity or the continuity of the original prin
ciple of classification and utilize other prin
ciples which the science of logic has proved
to be fundamentally erroneous in any classi
fication. Thus, Sternberg for instance, in 1926
uses as co-ordinated groups (a) histioid
tumors, with fibroma and sarcoma, (b) a
group which has no common name but which
consists of endothelioma, perithelioma, and
cylndroma¹, (c) cysts and epithelial tumors,
which group, among others, contains the
Krukenberg tumors which do not originate

¹It must be here mentioned that the cylndroma is not an en
tity but a special type of degeneration found in histioid as well as
epithelial tumors. This latter possibility is in contradiction to
the grouping of cylndromas under the heading (subordinated
group) of histioid tumors.

rise in pulmonary pressure averaging millimeters of mercury which soon returned to a level of 8.5 millimeters of mercury original level.

The systemic pressure fell to an average 53.5 millimeters of mercury and returned to a level of 130 millimeters higher than the original level.

In 3 animals the tumor was followed until death occurred. In both pulmonary embolisms and death occurred within a few days.

Carr¹ Gonadoma cell tumor benign. Highest mature follicular epithelial islands with mature follicular theca. Call—Eosin bodies.

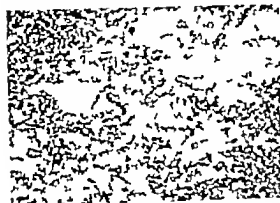


Fig. 3. Arrhenoblastoma, benign. Short trabeculae, clusters of pale polyhedral Leydig cells between.



Fig. 5. Arrhenoblastoma—mature type benign. Adenoma trabeculae Pick (glandular ducts corresponding to seminiferous ducts). Islands of pale fatty Leydig cells between.

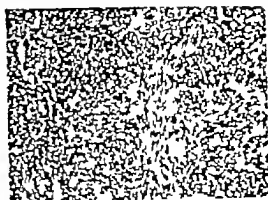


Fig. 2. Fibroma—specific type, benign. The cells are loaded with little fat droplets. Xanthofibroma Leeder-Friedl.



Fig. 4. Arrhenoblastoma, benign. Trabecular type.

from the ovary itself and corpus luteum cysts, which are not tumors in the sense of new growths.

Kermanner in a brilliant contribution in Veit's *Handbuch der Gynaekologie* gave a most valuable detailed description of the various ovarian tumors but as I know from personal communication, never attempted to establish a satisfactory classification. When he began to revise his findings from the point of view of the new embryological discoveries of the ovary he passed away. Miller in the most complete presentation of ovarian pathology which exists, in the third part of Volume 7 of the Henke Lubarsch textbook, uses a very complicated system of classification in which morphological, clinical and physiological criteria are all utilized simultaneously. The re-

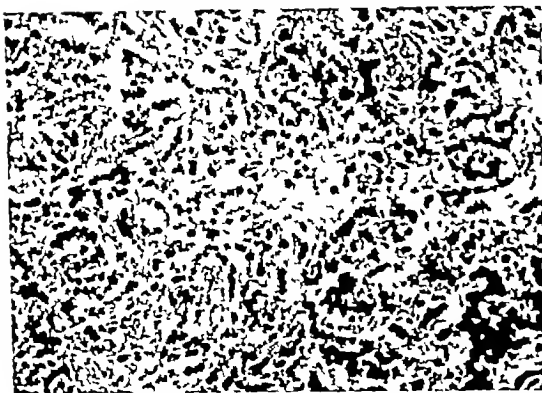


Fig 6 Dysgerminoma, benign Rows of single cell breadth

sult of such a classification is that the same tumor appears in different groups or headings—an error which the science of logic teaches should never occur in a well founded classification. Thus, for example, the tubular adenoma appears first under the heading of epithelial tumors and, second, under the heading of virilizing ovarian tumors. The tubular adenomas are both epithelial and virilizing at the same time but two characteristics which can be present in the same unit should not be utilized as co-ordinated headings in any classification. Conill, of Barcelona, in a complete resignation of giving anatomical foundations suggested a half clinical and a half morphological system of classification founded on four disparate characteristics: cystic, vegetative, solid, and hormonal. Three French authors,

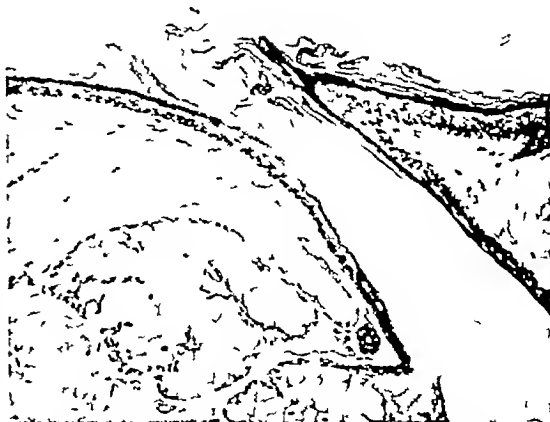


Fig 7 Dermoid, skin with sebaceous glands, benign Basal layer of epithelium loaded with pigment (colored patient)

R. Leroux, J. Levret, and Weinrott, established an anatomical classification which is limited to the epithelial tumors only. A suggestion of a working classification of adenexal cysts and neoplasms has been published by Counsellor and Broders which is meant to serve for clinical purposes. It probably will serve this function very well, but for the pathologist it is unsatisfactory because the first group—cysts—includes cysts of corpus luteum which are only the pathological dilatation of a physiological cavity, dermoid cysts, which are true neoplasms, and it separates the latter from teratomas which are found in the classification under B, neoplasms, 2, malignant, f, teratoma.



Fig 8 Teratoma of immature type—embryoma, malignant Loose mesenchymatous and epithelial adenomatous elements



Fig 9 Teratoma, malignant Immature type embryoma Round islands of cartilage surrounded by venous sinusoids, hemangioma venosum

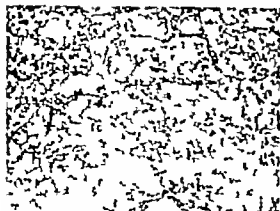


Fig. 2. Hypernephroma, benign. Solid, without hormone production. Not masculinizing.

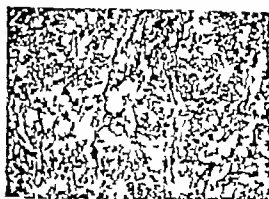


Fig. 1. Hypernephroma, benign. Massive, specific, masculinizing. The cellular elements vary from dark fetal type to pale lipid laden mature protoplasmic.

In Curtis textbook on obstetrics and gynecology Goodall gives a very detailed presentation of ovarian tumors using for the classification the embryogenesis of the ovary. Unfortunately at that time the new discoveries concerning the embryology of the ovary by Fischel and Gruenwald were not known and consequently Goodall used the old theory which traces all the epithelial structures of the ovary to the surface epithelium. This theory has since been discarded and, as it is incorrect, it could not be instrumental in explaining the histogenesis of ovarian tumors.

R. T. Frank in 1931 discussed the various classifications suggested up to this time and chooses for his work a simple modification of the Pfannenstiel Sternberg classification. He divides the tumors of the ovary into epithelial

tumors, connective tissue tumors and mixed tumors (embryomas). This is a grouping rather than a classification of ovarian tumors but it does give justice to the great variety of structure and the histogenesis of the ovarian tumor. Ewing in his famous monograph on tumors, similarly does not attempt to give a classification but merely an enumeration of ovarian tumors. The same is true for Pomeroy of Cleveland who merely enumerates 14 different types of ovarian tumors without superordinated or subordinated division. Likewise the *Pathological Index* of the American Medical Association lists numerous ovarian tumors in no particular order.

When we attempt to establish a histogenetic system and classification of ovarian tumors, one test for its working capacity is whether

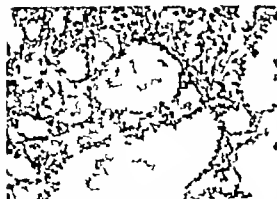


Fig. 4. Mesonephroma, benign. Cystic type. The cysts lined with hobnail shaped endothelium like cells.

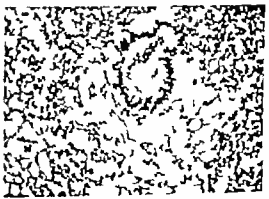


Fig. 3. Mesonephroma, malignant. Pterioepithelioma in the center.

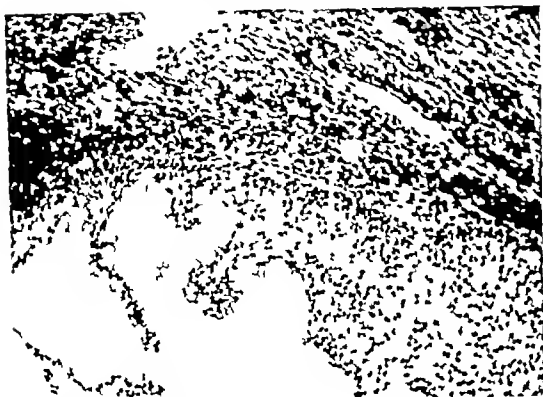


Fig 14 Brenner tumor, benign The glandular part is well developed

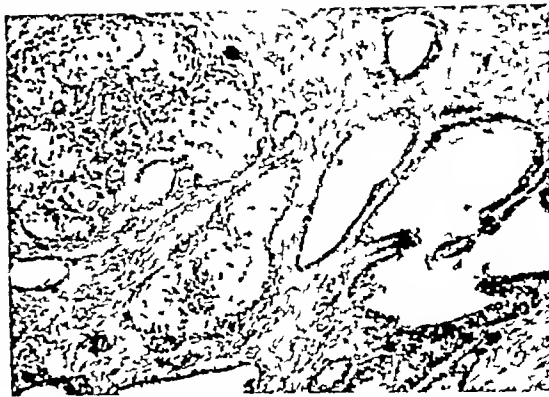


Fig 15 Brenner tumor, benign The epithelial islands with cystic degeneration

the great number of the so called rare ovarian tumors recently discovered and investigated (dysgerminoma, Brenner tumor, arrhenoblastoma, etc) can be placed into the system without disrupting the system or the conception of the tumor. According to the laws of logic, no tumor should appear under different headings in the same classification. This, of course, does not mean that we can avoid putting tumors which are clinically and morphologically almost identical into two different groups according to the histogenesis. For instance, there are two different types of pseudomucinous cystoma from the histogenetic viewpoint, but which clinically and even histologically are almost identical. One develops from the prosoplastic surface epithelium and the other represents the intestinal part of a teratoma. The histogenetic classification has to place these two tumors in different groups. This does not weaken the histogenetic system for it is very probable that, with increasing knowledge and experience, tumors of different histogenetic origin may prove to be clinically different especially with regard to the tendency of malignant degeneration.

The first group is represented by pathological changes which the clinician is prone to call tumors, meaning thereby, enlargement of the organs as indicated by palpation. This enlargement, however, is not the result of neoplastic transformation. This group is represented by cysts which signify dilatation of physiological cavities by retention of secretion. This term, "cyst," must never be con-

fused with the term "cystoma" for the suffix "oma" means a real tumor, analogous to a lipoma, neuroma, fibroma, etc. Whenever the diagnosis of a cyst is made, one must trace back its origin to a physiological cavity which has given rise to a cyst as a result of retention of its secretion. In the ovary there are three types of cavities which may become cystic by storing pathological amounts of fluid: the follicle, the corpus luteum, and the corpus atreticum. These result in follicular cysts, corpus luteum cysts, and corpus atreticum cysts. The latter arise from corpora atretica with luteinized theca which are generally found only in pregnancy. These cysts may give rise to the well known bodies, having a yellow wall with a red center which compose the enlarged ovary in hydatid moles and chori-



Fig 16 Brenner tumor, benign Epithelial islands without glandular inclusions. The surrounding fibromatous tissue presents hyaline degeneration

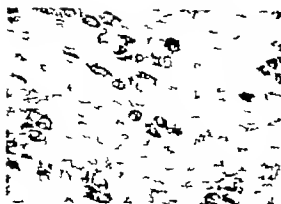


Fig. 7 Solid gangliocarcinoma of the ovary benign

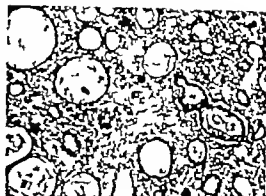


Fig. 8 Krukenberg tumor malignant. Cystic deposits—right side from the center—granular formation, left side from the center—lymph vessel with free floating pigment ring cells

onic epitheliomas, as a result of hyperhormonic secretion i.e. by an abundance of prolactin B with secondary bleeding in the cavity. The correct and accurate name for these would be luteinized corpora atretica cysts, but this has been replaced by the term lutein cysts as suggested by the first investigators.

The true ovarian neoplasms must be divided according to the origin of the tissues which would place them into two groups. The first group consists of tumors developing from tissue which is found in the normal physiological ovary. These tumors, inasmuch as they arise from the ovary itself can be called *ovariogenic*. This group is represented by two members, both developing from the mesenchymatous core of the ovary. The first is the granulosa cell tumor which develops from fetal remnants of the tissue which physiologically develops into granulosa. Thus the tumor duplicates the embryological development of the granulosa. It can be subdivided according to the analogy with the fetal development of the follicles as (a) homogeneous immature corresponding to the phase before the development of the germinal cords and thus similar to an immature fibroma (b) trabeculated corresponding to the phase of germinal cords and (c) imitating the mature follicle called mature folliculoid or folliculoma. The second tumor corresponds to the unspecific component of the mesenchymatous core which normally furnishes the interstitial fibrous stroma. This tumor is the fibroma with a subgroup charac-

terized by luteinization—the so called xanthoma fibroma theca-cellulare of Loeffler Priesel.

The second group of ovarian tumors develops from tissue which is not found in the normal ovary but is found elsewhere. An adequate name for these tumors would be *heterotopic*—which is the verbal Greek translation of “other places.” I prefer the name *heterotopic* to *heterogenetic* which would mean neoplasms developing elsewhere and would not include tumors of non-ovarian type which develop from ovarian constituents. The heterotopic tumors can be divided into two subgroups. First, those tumors which may adequately be placed in the group classified by the heading *Errors in Differentiation* for they arise from constituents of the ovary which, as a result of failure of differentiation, develop into non-ovarian tissues. Second, those tumors which consist of non-ovarian tissue which was shifted into the ovary as a result of pathological changes. This shifting of non-ovarian tissue into the ovary may occur during fetal time, by developmental error or in adulthood by either surface implantation of normal tissue or metastases of neoplastic tissue. The group of pathological differentiation can again be subdivided into two groups according to the origin of the error in differentiation. This error may occur in the surface epithelium which was formerly called *germinal epithelium*—a name which arose from the misconception that this epithelium produces

oogonia and spermatogonia, i.e. it produces the germinal cell. Since we know today, as a result of the discovery of the germinal route that the germinal cells arise from the posterior wall of the primitive gut and enter the developing ovary from the back or dorsal side, from its hilum, there is no justification for calling the surface epithelium the germinal epithelium. The latter is a part of the celomic epithelium and, therefore, has the same origin as the epithelium which is situated at the lateral pole of the gonad by invagination and inclusion forms the müllerian duct. This müllerian epithelium, later by differentiation, develops into high columnar ciliated, or serous epithelium of the tube, into the glandular epithelium of the cavity of the uterus and into the high pale mucinous epithelium of the cervical canal. Ovarian epithelium, frequently, as described for the first time by Walthard, invaginates and forms by separation from the surface, the so called Walthard cysts. These little cysts may give origin to cystomas later or even to neoplastic proliferation by differentiation of the epithelium. The differentiation may parallel the potentialities of the müllerian duct. (Formerly this would be explained by the conception that müllerian cells were misplaced medially on the surface of the ovary. Today, however, we discard this primitive mechanical conception and prefer the statement that in the early stages of development, cells possess almost every prospective potentiality and that these potentialities decrease gradually as development and differentiation take place, with the exception of the one that harmonizes with the localization of the cell. In the case of the aforementioned cysts, the developmental error consists in the fact that one of these potentialities is not extinguished.) If the inclusion cyst duplicates tubal development, it forms a serous ciliated cystoma. If it duplicates endometrium, an endometrioma is formed. If it duplicates cervical epithelium, a pseudomucinous cystoma is formed. The similarity of the tubal epithelium and the serous cystoma has been known for a long time and has been investigated accurately by cytologists and recently emphasized by Russian authors. The analogy between endometrium and endometrioma is responsible for

the name of this tumor. Endometriomas of this origin have to be traced back to the adenoserositis of Rob. Meyer and separated from the implantation endometriomas of Sampson. The similarity between the epithelium of pseudomucinous cystomas and cervix has puzzled many investigators. Even the unjustifiable theory of an implantation of tissue arising from a cervical menstruation which does not exist has been offered as an explanation. The difference between mucinous and pseudomucinous secretion which was stated in old times, based on the presence or absence of coagulability by alcohol is not justifiable, for today we know that as a result of changes in the colloidal phase, the coagulability with alcohol decreases with increasing age of the mucin.

The cystomas, especially the serous and the mucinous, could be characterized by two more descriptive attributes: unilocular or multilocular and simple or papillomatous. Very frequently, the tendency to form papillomatous projections in the serous cystoma arises, not only in the depth, that is, in the wall of the cyst, but simultaneously in the surface epithelium, thus giving origin to superficial papillomatous projections. When only the surface epithelium develops into papillomatous projections, we see a surface papilloma which in the classification has to be co-ordinated with the papillomatous cystoma. Combination of serous cystoma with surface papilloma and fibroma (by fibromatous thickening of the septa) is not too rare: papillomatous cystofibroma or fibrocystoma.

A second possibility giving rise to the second group of tumors resulting from an error in differentiation develops from the depth and not from the surface of the organ (i.e. it arises from the mesenchymatous core). The cells of this tissue partially give origin to the unspecific interstitial tissue of the ovary and partially contribute to the formation of the germinal cords by furnishing the auxiliary cells which serve to build the follicle and later become transformed into granulosa cells—as Fischel has definitely proved. It may happen that one of these cells during mitotic division loses one X chromosome and so becomes male in character. Such a cell has the tendency and

potency of the mesenchymal core of the testicle as a fetal remnant and, developing in a neoplasm, it gives origin to a tumor which duplicates the fetal development of the testicles but without spermatogonia. This tumor likewise has three phases (a) homogeneous immature (b) trabecular like male germinal cords (c) adenomatous—duplicating mature testicular ducts as adenoma testiculare. This tumor like fetal testicle contains a great number of interstitial Leydig cells which produce a male hormone and consequently may have a masculinizing effect on the bearer. It is called arrhenoblastoma.

A third possibility arises when as a result of developmental error in the sex chromosomes, the type and mechanism of which error we do not understand nor know as yet, the cells develop in neither adequate male nor female direction but become sexually indifferent or neutral. This error occurs in the ovary as well as in the testicle and very characteristically in high incidence in hermaphroditic gonads which probably develop a neutral zone between the zones of different sexes. Consequently this tumor develops identically in ovaries, testicles, and hermaphroditic gonads. It consists of large round cells with a pale delicate protoplasm arranged in alveoli between connective tissue septa or in rows between connective tissue fibers. Formerly this tumor was described as a large cellular carcinoma or sarcoma. It was not until the French investigator Chevreau found it in the testicle and traced it back to the spermatogonia that it was called a seminoma. Rob Meyer stressed the fact that the ovarian dysgerminoma never masculinizes the bearer and produces no hormones. He also suggested the name dysgerminoma to show that the tumor develops from both—"dis"—gonads or germinal glands (and not dysgerminoma from dys meaning wrong, as for example in dysmenorrhea). The dysgerminoma has a great tendency to disintegrate and to undergo fatty degeneration. The stroma responds to the fatty products of degeneration by producing granulation tissue consisting of lymphocytes epithelial cells, giant cells of the Langhans type—thus duplicating tuberculous granulation tissue. This coincidence in many cases is re-

sponsible for the mistake made by some observers who stated a coincidence of dysgerminoma and tuberculosis.

The tumors developing from misplaced tissue contain as the first group those arising from displacement of cells during fetal time. These cells have multiple potencies and are called blastomeres by embryologists. When they develop into tumors, they give rise to a poorly organized mixture of tissues called teratomas. Formerly the word teratoma was used to include the attribute of malignancy. This is not justifiable for benign teratomas undoubtedly exist. The term itself means a tumor composed of tissue the presence of which in this locality the observer considers a miracle. It is better to use the word teratoma without anticipating its clinical evaluation and to add the attribute, benign or malignant. The most frequent example of the mature teratoma is the dermoid. The immature teratomas, whose tissues do not surpass the limit of fetal differentiation are called embryomas. Further classification of teratomas can be given by the origin of the tissues they contain. monophylloma—when the tumor consists of tissue of one germinal layer only diphylloma or triphylloma when it consists of tissues of two or three germinal layers. The displacement of cells may occur at a much later phase of embryonic life—at a time when the cells have already acquired a definite differentiation. At that time it may occur that cells of organs which develop in the vicinity of the ovary are displaced in the field of the ovarian parenchyma. Inasmuch as the ovarian pedicle develops comparatively late, the ovary remains in close connection with other tissues for a long period. Gradually however it becomes separated from the surrounding tissues by the formation of two folds or grooves which enclose the ovarian ligament. If these two folds cut in too deeply or too far from each other they may add extra-ovarian tissue to the ovarian stock. This explains the origin of the mesonephroma which presents mesonephromatous tissue. Frequently the hilum of the ovary contains little islands of suprarenal cortical tissue. The fact that such islands are much more frequently encountered in the newborn than in

the adult, proves that they generally disappear by involution. If they persist and give origin to tumors, hypernephromas arise. The Brenner tumor consists of islands of transitional squamous epithelium which are embedded in a fibromatous stroma and may enclose glandular cavities lined with high columnar, mucinous epithelium. The combination of intraepithelial glands (i. e. mucinous glands embedded in stratified epithelium) is characteristic for the neighboring uropoietic system and is found physiologically in the pelvis of the kidney and in the urethra. The fibromatous component is only a secondary response of the surrounding stroma. When from the neighboring sympathetic ganglia elements are encased in the ovarian tissue, ganglioneuromas may develop.

Implantation in the adult can be found under two entirely different conditions. Thus, carcinoma cells arising from the mucous membranes of the abdominal cavity, most frequently from the stomach, then small or large intestines, gall bladder, or pancreas, may be grafted to the ovarian surface via the lymph vessels from the side of the hilum or from the surface. They give rise to metastatic carcinomas, formerly called Krukenberg tumors in spite of the fact that Marchand and not Krukenberg first described them.

Implantation of endometrium by retrogressive menstruation through the fallopian tube has been described by Sampson as giving rise to ovarian endometriomas. This type of endometrioma is histogenetically but not morphologically different from the proso-plastic endometrioma here described. Once a certain stage of development and size has been reached, the two endometriomas may look identical.

With exception of the metastatic Krukenberg carcinoma, this classification mentions no malignancies—neither carcinomas nor sarcomas. This is entirely opposed to other systems of classification which classify certain groups as malignant by themselves. Kermanner, for instance, includes in his book a group called "granulosa cell carcinomas." By so doing, he denies the existence of benign granulosa cell tumors. In general, the older systems, distinguish so called primary carci-

CLASSIFICATION OF OVARIAN TUMORS

Cysts

- a. Follicular
- b. Corpus luteum
- c. Corpus atreticum, luteinized—lutein cysts

True tumors

- A. Ovario-genic—derived from ovarian tissue
 - a. Granulosa cell tumor
 - I Homogeneous
 - II Trabeculated
 - III Follicular
 - b. Fibroma
 - I Simple
 - II Luteinized—xanthofibroma theca-cellulare
 - c. Myoma, angioma, luteinoma
- B. Heterotopic—derived from tissue not normally present in ovary
 - a. By pathological differentiation
 - I From surface epithelium—proso-plasia in direction of muellerian duct
 - 1 Serous cystoma—tube
 - 2 Endometrioma—endometrium
 - 3 Pseudomucinous cystoma—cervix
 - II From mesenchymal core by error in sex chromosomes
 - 1 Arrhenoblastoma—male
 - 2 Dysgerminoma—neutral
 - b. From displaced tissue
 - I In fetal life
 - 1 Early—teratoma
 - Mature—dermoid, e. g.
 - Immature—embryoma
 - 2 Late—tissue from vicinity
 - Ganglioneuroma
 - Hypernephroma
 - Mesonephroma
 - Brenner's tumor—urogenital epithelium
 - II In adult life
 - 1 By implantation—endometrioma
 - 2 By metastases of malignant tumors—Krukenberg carcinoma, e. g.

The cystomas of B a I 1-3 are to be characterized as unilocular or multilocular and as simple or papillomatous.

The surface papilloma may be classified under B, a, I, 1, papillomatous the folliculoma lipidique Lecthe tentatively under A, a, the myxoma under B b I 1.

The arrhenoblastoma of B a II, 1, may be characterized as homogeneous trabeculated or adenomatous-testicular.

nomas of the ovary, i. e., tumors which originally began as malignancies, and secondary carcinomas of the ovary, i. e., tumors which originally began as benign tumors but which underwent malignant degeneration thus becoming malignant—and not metastases in the sense that the word secondaries is generally used.

Concerning the first group, the primary carcinoma, which starts out as such, a critical consideration raises certain doubts. Thus, we have very accurate knowledge of beginning carcinomas of the skin and of the cervix uteri many of which are smaller than 1 millimeter

in diameter. Numerous of these cases have been found accidentally by investigators while examining supposedly normal organs. In the cervix uteri, the probability of encountering a small, beginning clinically latent carcinoma during the examination of a supposedly normal organ is as Smith and Pemberton and I have found about 2 to 3%. No small carcinoma of the ovary is described in the literature. Many thousands of so called normal ovaries have been examined carefully by gynecologists, histologists, and pathologists throughout the world. I have carried out systematic examinations along these lines for many years but never have I nor anyone else discovered a small beginning carcinoma of the ovary. A few cases of pea-sized granulosa cell tumors have been found and some of these have been described even as beginning malignancies, but this error was made as a result of the same mistake which caused granulosa cell tumors to be diagnosed as malignant entities. I have had the opportunity to find and to examine several of these small granulosa cell carcinoma germs. They all showed the same cell character which the larger benign granulosa cell tumors present. Neither polymorphous nor atypical cells were seen, thus proving themselves to be young immature but not malignant growths. Evidently no small ovarian carcinoma a few millimeters in size exists for if it did it could not have escaped and at least 1 or 2 cases would have been discovered as a result of the careful examination of thousands of slides by experts throughout the world.

The conclusion which we are compelled to draw from this fact is that carcinoma of the ovary does not originate in this way. It probably does not originate primarily from a carcinomatous germ which is analogous in its cells to the progressed carcinoma but by malignant degeneration of benign neoplasms. This conception is supported by the finding of progressed benign ovarian neoplasms with partial malignant degeneration as has been found by several observers. We must therefore add to each of the primarily benign group of our classification the corresponding malignancy developing by secondary malignancy

degeneration of the primary benign neoplasms. Thus, for example, we have adenopapillary cystoma and adenopapillary carcinoma fibroma and sarcoma teratoma and teratoid carcinoma, sarcoma or sarcomatoid carcinoma, the type of malignancy corresponding to the tissue of which the benign tumor consists. Generally accurate examination of several slides from several parts of a tumor presents portions which permit by transitions the tracing back of the malignant to one of the benign tumors. Sometimes in some malignant tumors degeneration and dedifferentiation has gone too far to permit this tracing back of the carcinoma to a special type of benign tumor. In such cases, of course classification is not possible. All we can do is to describe the tumor and register it for instance as a nondescript solid carcinoma of alveolar structure with polyhedral cells and irregularly shaped hyperchromatic nuclei.

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TABLE II—HABITUAL ABORTION

Case No	Name	Age	Para	Gravida	Previous abortion	Last pregnancy			
						Bleeding	Pain	Therapy	Results
25	C. M.	25	0	3	6 mo 3 mo	For 2 wks at 3 mos	yes	Antultrin S Wheat germ oil Corpus luteum hormone	Normal full term male
26	L. C.	30	0	4	6 mo 3 mo 6 mo	no	no	Antultrin S Wheat germ oil Thyroid extract	Normal full term male
27	E. W.	32	0	3	6 wk 11 wk	Twice 2 das at 3 and 6 mo	yes	Antultrin S and corpus luteum hormone Wheat germ oil Thyroid extract	Normal full term male
28	M. L.	32	0	3	2½ mo 2 mo	no	no	Follutein Wheat germ oil Thyroid extract	Normal full term female
29	C. K.	30	1	3	8 wk	no	yes 2 days	Antultrin S Wheat germ oil	Normal full term female, Mild preeclamptic toxemia
30	J. C.	27	0	2	6 wk	Profuse at 5 mo	yes	Corpus luteum hormone Wheat germ oil	Miscarried Was a case of missed abortion
31	M. A.	22	0	2	6 wk	From 6th to 8th wk.	no	Antultrin S Wheat germ oil	Normal full term female
32	J. C.	28	0	2	6 mo	no	yes 3 days	Wheat germ oil Antultrin S Thyroid extract	Normal full term female
33	C. R.	29	1	3	6 wk.	Profuse at 6 wk	yes	Corpus luteum hormone Wheat germ oil	Miscarriage at 6 wk. initiated by malarial fever
34	R. S.	26	0	3	7 wk 12 wk.	For 2 wks at 3½ mo	yes	Corpus luteum hormone Wheat germ oil Thyroid extract	Miscarriage at 3½ mo
35	H. T.	25	0	2	8 wk	For 7 days at 8 wk	yes	Corpus luteum hormone Wheat germ oil Thyroid extract	Normal full term female
36	H. C.	29	1	3	3 mo	no	yes 4 days	Corpus luteum hormone Wheat germ oil	Pregnancy now 6½ months

evidence of hypothyroidism, as obesity, irregular menstrual periods, slow pulse, etc. Basal metabolic rates were not taken in all cases.

We have classified our cases as "threatened abortion" if cramping pain in the lower abdomen persisted longer than 24 hours or if a patient had bleeding, whether only spotting or in larger quantities. We were careful to eliminate any bleeding that might arise from an erosion or lesion in the lower genital tract. Cases were classified as "habitual abortion" if the patient had had 2 or more spontaneous abortions or had had 1 previous abortion immediately prior to, or attempted to abort during her present pregnancy.

Twenty-four cases of threatened abortion, including patients under our antepartum care or first seen when attempting to abort, were treated as outlined herein. In 3 of these cases the abortion went to completion despite therapy. Of the remainder, 14 have been delivered of normal, full term children, 1 has now passed

the period of viability, and the remainder have retained their pregnancies without further signs or symptoms of abortion. This represents a successful arresting of the abortion in 87 per cent of these cases.¹

In the habitual abortion group 12 patients were treated and of this number 8 have been delivered of normal, full term, healthy infants, while another is now pregnant 6½ calendar months. Three patients aborted despite treatment. In 1 of these, Case 33, the abortion was precipitated by an attack of malaria. Another, Case 30, was a case of missed abortion, and was not seen until she complained of vaginal bleeding and abdominal cramps. Though the fundus was not as high as it should have been for a 5 months' pregnancy, therapy was instituted. After 10 days of therapy the patient expelled a macerated fetus. These 12 cases, prior to treatment, had a total of 21 pregnan-

¹Since submitting this article for publication all patients listed in Table in whom the abortion was successfully combatted have delivered full term normal infants.

TABLE I.—THREATENED ABORTION

Case No.	Name	Age	Para	Ovula	Previous abortion	Bleeding time	Pain	Wheat germ oil	Antultrin S	Corpus luteum hormone	Thyroid extract	Results
	F. B.	20				6 wk.	do.	yes	0.25	yes	yes	Pregnant now no.
	K. B.	20				no	wk.	yes	yes	yes	yes	Pregnant now 11 wk.
	R. B.	27				do.	do.	yes	yes	no	no	Delivered normal term male
	J. E. C.	26				10 wk.	yes	yes	yes	no	no	Delivered normal term male
5	R. C.	27				no	1 1/2 hrs	yes	no	no	yes	Delivered normal term female
6	C. C.	25				8 wk.	yes	yes	yes	yes	yes	Pregnant now no
	H. E.					no	3 hrs	yes	no	no	yes	Delivered normal term male
6	C. F.	27				no	5 hrs	yes	no	no	yes	Delivered term male*
8	H. O.					1 mo	yes	yes	yes	yes	no	Delivered normal term female
	L. H.					8 wk.	yes	yes	yes	yes	no	Delivered normal term male
11	F. L.	24				1 1/2 hrs	yes	yes	yes	yes	no	Delivered normal term male
	A. L.	21				no.	yes	yes	yes	no	no	Delivered normal term female
	W. M.					6 wk.	yes	yes	yes	yes	yes	Delivered normal term male
14	C. P.	29				6 wk to wk	yes	yes	yes	yes	yes	Delivered normal term female
	J. R.	24				no	yes	yes	yes	no	no	Delivered normal term female
16	E. V.	24				6 wk to wk	no	yes	yes	yes	no	Pregnant now 8 wk
17	M. W.	27				no	yes	yes	yes	yes	yes	Delivered normal term male
18	J. O.	24		3		no	yes	yes	yes	yes	no	Delivered normal term male
19	H. R.	24				2 1/2 hrs	yes	yes	no	yes	no	Miscarried at 1 1/2 mo
20	D. D.	24				wk	yes	yes	yes	yes	yes	Miscarried at wk
21	F. H.	24				no	yes	yes	yes	yes	no	Miscarried at mo
22	G. R.	22		3		3 hrs	yes	yes	no	yes	no	Pregnant now 3 mo
23	L. R.	24				3 hrs	yes	yes	1-10	yes	yes	Pregnant now no
24	M. S.	25				6 wk to wk	no	yes	no	no	yes	Pregnant now no

*Stillborn.

We have used wheat germ oil in the treatment of 36 cases of spontaneous, threatened or habitual abortion in combination with the anterior pituitary like hormone, progesterone, and/or thyroid extract. The wheat germ oil was of the cold pressed type and was never prescribed in more than a 2 ounce quantity. The patient was advised to keep the oil in the refrigerator because of the rapidity with which the oil deteriorates (18). The daily maintenance dose ranged from 1 to 1 1/2 drams unless the patient began to show signs of threatened abortion or showed signs of threatened abortion when first seen. Eight to 12 drams were given during the first 24 hours to these patients as advised by Shute (17) and then the patients were placed on the daily maintenance

dose. Oil was given until patients reached 8 to 8 1/2 calendar months of pregnancy.

The anterior pituitary like hormone in the form of antultrin S was administered intramuscularly in 1 cubic centimeter doses given at weekly intervals until the patient was pregnant 4 to 4 1/2 calendar months. In a few cases injections were continued until the seventh calendar month.

One rabbit unit of progesterone was administered daily intramuscularly when cramping or bleeding was actually present. Upon cessation of these symptoms the corpus luteum hormone was discontinued and antultrin S substituted.

Thyroid extract in 1/10 to 3/5 grain doses twice daily was given to all patients showing

EFFECT OF NITROUS OXIDE OXYGEN ETHER ANESTHESIA UPON OXYGENATION OF MATERNAL AND FETAL BLOOD AT DELIVERY

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IN an earlier study (6) data were presented concerning the effect of certain commonly used obstetrical anesthetics upon the maternal and fetal blood at birth. In that report attention was directed particularly to the influence of ether, nitrous oxide, and cyclopropane, each of which was accompanied by rather characteristic changes in blood oxygenation. These may be summarized as follows:

In general, ether anesthesia produced a definite elevation in maternal oxygen capacity and in the oxygenation of maternal venous blood, the fetal circulation showed a decidedly high oxygen level. Nitrous oxide, supposedly administered with at least 20 per cent oxygen, produced definite maternal and fetal anoxemia. With cyclopropane the maternal arterial and venous specimens contained elevated and almost equal amounts of oxygen. The blood of infants delivered from these mothers was not so well oxygenated as that of those born under ether, though more satisfactory than that of infants born under nitrous oxide oxygen. The general relationship of oxygen content to the presence or absence of apnea in all the infants studied was discussed in that paper and will be referred to later.

The combination of nitrous oxide oxygen with ether has been employed extensively at the Boston Lying-in Hospital as a comparatively safe anesthesia for both mother and baby. Asphyxia attributable to its use has not been clinically apparent, and theoretically it offers a margin of safety over nitrous oxide and oxygen alone. With the latter mixture induction is easy and rapid, but anesthesia can be carried only to a certain depth without increasing the nitrous oxide at the expense of the oxygen. If the proportion of the latter

present is only 20 per cent, an actual and often marked anoxemia may result for mother and baby if the oxygen be further diminished. The effects of this have been well shown by Eastman (2). The addition of ether vapor should obviate this difficulty and permit relaxation and the other benefits of deeper anesthesia without jeopardizing the oxygen percentage. In this hospital the proportion of oxygen is never knowingly allowed to fall below 20 per cent, should deeper anesthesia be required, as is usually the case, a small but variable amount of ether vapor then suffices to produce this effect. The widespread use of this technique in this and other clinics, and the data secured for ether and for nitrous oxide and oxygen used separately aroused interest in the effect of their combined use. It was assumed that, could figures be obtained, they would show oxygen levels not so high as those for ether but above the anoxemia approached with nitrous oxide and oxygen.

On first attempts it seemed technically impossible to make reliable measurements of blood oxygen in the presence of the two anesthetics. Each interferes to a different degree with the standard Van Slyke-Neill technique for gas analysis, and for each a special modification of that technique has been devised. Thus the method of Shaw and Downing gives an accurate measurement of oxygen in the presence of ether, and that of Orcutt and Waters satisfactorily corrects for the presence of nitrous oxide. No success was obtained by attempts to combine both special methods for the particular problem under study. It was noted, however, that in samples containing either nitrous oxide or ether alone and analyzed by the standard Van Slyke-Neill technique a greater inaccuracy occurred in the presence of the former. Nitrous oxide in the blood gave results at

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cases resulting in only 3 live births. With therapy the same group in 12 pregnancies have already been delivered of 8 full term, living children.

ANALYSIS OF RESULTS

We believe that as yet there is no single substance that will consistently prevent spontaneous or habitual abortion, and that a combination of substances of proved value will give the highest percentage of results. Wheat germ oil is used as the basis of treatment in all of our cases with progestin or the anterior pituitary like hormone and/or thyroid extract added when deemed necessary. Though our determinations of the antiproteolytic powers of the blood of women who are habitual aborters or undergoing spontaneous abortion, before and after the use of wheat germ oil are inconsistent and inconclusive there are 3 cases in this series that clinically offer a great deal of proof as to the efficacy of wheat germ oil.

Each of these patients, Cases 16, 24, and 27 stopped taking the wheat germ oil of their own accord and even though they were on maintenance doses of thyroid and progestin they promptly began to attempt to abort a second time during the same pregnancy. Resumption of wheat germ oil therapy was followed by a prompt cessation of bleeding and cramping pain and allowed the pregnancy to proceed with no recurrence of these symptoms.

Of the 22 children delivered from this group only 1 showed any evidence of deformity and that was a mild hypospadias in the child of Case 8. This deformity is so slight, in fact, that surgical correction will not be necessary.

CONCLUSIONS

Wheat germ oil therapy forms a valuable basis for the treatment of spontaneous and/or habitual abortion.

2. Wheat germ oil therapy should be fortified by the administration of progestin and/or thyroid extract when necessary.

3. The fear of delivering a malformed fetus in cases in which spontaneous or habitual abortion has been successfully combatted is overemphasized.

4. All efforts should be made to control spontaneous abortion or habitual abortion by the use of all known remedies which have been proved of value.

5. We present our results in 36 patients so treated to substantiate our views.

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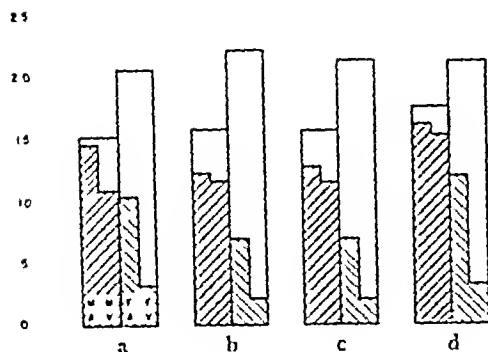


CHART 1 Maternal and fetal oxygen relationships: M A, Maternal arterial blood, M V, maternal venous blood, F A, fetal arterial blood, F V, fetal venous blood. The height of the column represents volumes per cent of oxygen capacity (plain) and of oxygen content (shaded). Diagram a is taken from data published by Lastman a) no anesthesia, b, nitrous oxide oxygen and ether, c, nitrous oxide oxygen, d ether.

irregularly and in small amounts would be a less distorting factor. Accordingly it was decided to make determinations by the method of Orcutt and Waters, correcting for nitrous oxide, and to admit a small error due to ether present. It must be remembered in considering the data that this error would result in figures for blood oxygen which were slightly above the true amount present. This error was probably maximal in the maternal arterial blood and minimal in the fetal venous blood, since ether must have been greatest in the one and least in the other.

The technique of securing blood samples from the maternal circulation and the umbilical vein and arteries at delivery was that described in the previous study. When 4 samples were obtained at a given delivery, exact synchronization was not always achieved, but the fetal blood in all instances was representative of that in the infant's circulation before or at the onset of respiration. The method of Adrian was used for storing samples over mercury in collecting syringes. Patients were anesthetized by the regular staff of the hospital and by the standard technique as here described. The majority of deliveries were normal as shown in Table I which presents the data from the 28 infants studied.

It is obvious from the table that the results varied over a wide range. This is due to a number of uncontrolled factors which include

TABLE II—AVERAGE OXYGENATION OF BLOOD AT DELIVERY

		Maternal		Fetal			
	Anesthetic	Oxygen capacity	Oxygen content		Oxygen capacity	Oxygen content	
			Arterial	Venous		Arterial	Venous
10	None*	15.4 vols per cent	14.7	11.0	10.5 vols per cent	10.5	3.3
5	Nitrous oxide oxygen and ether	15.0	14.4	11.6	10.4	7.0	2.1
	Nitrous oxide and oxygen	15.0	12.8	11.5	10.5	7.0	2.1
pe ous	Ether	12.6	10.6	10.3	10.1	12.0	3.3

*Data from Eastman (3)

anatomical differences, the element of time, the use of pre-anesthetic medications, and the individualization of anesthesia to a given patient at a given stage. The levels of the three substances supplied to the patient—oxygen, nitrous oxide, and ether—are not static, but must be varied constantly by the careful anesthetist to meet the demands of the moment. However, as already stated, the anesthetists always attempted to keep the oxygen supply at or above a minimum of 20 per cent of the anesthetic mixture.

The results are most easily appreciated if compared with data from deliveries without anesthesia and from those in which ether or nitrous oxide and oxygen alone were used. To simplify this comparison, averages are given in Table II and presented graphically in Chart 1. Those in diagram a for deliveries without anesthesia are taken from data published by Lastman (3) whose studies of fetal blood gases originally aroused our interest in the subject. It is obvious that even under normal circumstances the newborn infant has a low supply of oxygen. Diagram b, Chart 1 shows the results obtained in the present study, while c and d portray averages from our earlier studies of deliveries under nitrous oxide and oxygen and under ether. The effects of these have been described briefly at the beginning of this paper. The similarity between diagrams b and c is at once apparent and indicates that the addition of ether did not modify the anoxic effect of nitrous oxide-oxygen anesthesia in the patients.

TABLE L—DELIVERIES UNDER NITROUS OXIDE OXYGEN AND ETHER

Delivery*	Maternal					Onset of respiration s	Fetal				
	Oxygen capacity	Arterial oxygen	Per cent	Venous oxygen	Per cent		Oxygen capacity	Arterial oxygen	Per cent	Venous oxygen	Per cent
N D.		10.7	79	19.2	36	A	12.2		36		11
N D	17	14.6	2		61	A	12.2	6.6	29.6		29
N D.	16	10.2	66	2.2	31	B	12			1	2
N D	1		74	1	2	B	16.6	6	36	64	1.6
Br	1	1	66	2	5	C	17.5		44		
6 Cas	5.1		21.2			A		3		36	24
Average of 6	6		79	20.6	27.6		20.6		36	27.1	21.1
N D	1			1	26	B	22.7		14.7		3
8 N D.	29			27	22	A	22.2	6	23.6	2	
L F	1.7				17	A	24.6	2	14.2		17
10 Cas	1				71	A	26.6	6	5	14	
N D	2				23	A	27	20.6	47		
Average of 1	1			12.6	21		22	6	26.2	71	79.24
N D						A	21		26		1.6
N D						A	29.6		46.6		29
14 L F						A	27.1		13		
5 N D						A	29	5	17.6	7	3.6
16 N D						A	30	6	49		
17 N D						B			2		2.7
8 Cas						A	23.2	6	21.6		
19 N D						B	21.1	6.6	21.6	20	29
20 N D						A	22.6		24		2
21 N D						A	26		20.6		23.6
N D						A	24		19	65	
22 N D						A	26	20	26		
23 L F						A	23.6	7	26.6		20.6
24 Cas						A	20.6	20	20.5		
25 Face pres- entation						B				26	
27 L F						B	24.6		22		2
28 Cas						A	22		2		20
Average of all fetal arterial, all fetal venous							22.4	7.29	21.5	16	9.11

*N D—Normal delivery, L F—low forceps, Br—breach, Cas—cesarean.

†A—immediate, B—delayed, C—delayed and resuscitation required.

*Average of 1, †Average of 6, ‡Average of 10.

least 2 volumes per cent too high for the oxygen present moreover repeated determinations upon the same sample gave inconsistent results. With ether on the other hand both the standard technique and the Orcutt and Waters modification showed regularly less than 1 volume per cent error and this was always toward a falsely high oxygen level. Therefore in blood containing the two dis-

turbing substances, one had a choice between using a method which corrected for the large and inconstant error due to nitrous oxide, or a method which corrected for the small and constant error due to ether. Moreover nitrous oxide being the basal anesthetic, might be expected to be present in comparatively large quantities in the blood as the results proved while ether which was added

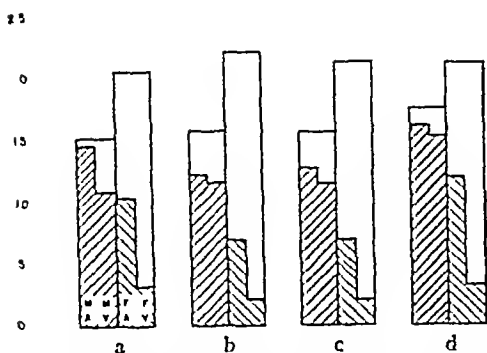


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ps ous	Ether	11.6	16.2	15.3	21.3	12.0	3.3

*Data from Eastman (3)

anatomical differences, the element of time, the use of pre-anesthetic medications, and the individualization of anesthesia to a given patient at a given stage. The levels of the three substances supplied to the patient—oxygen, nitrous oxide, and ether—are not static, but must be varied constantly by the careful anesthetist to meet the demands of the moment. However, as already stated, the anesthetists always attempted to keep the oxygen supply at or above a minimum of 20 per cent of the anesthetic mixture.

The results are most easily appreciated if compared with data from deliveries without anesthesia and from those in which ether or nitrous oxide and oxygen alone were used. To simplify this comparison, averages are given in Table II and presented graphically in Chart 1. Those in diagram a for deliveries without anesthesia are taken from data published by Eastman (3) whose studies of fetal blood gases originally aroused our interest in the subject. It is obvious that even under normal circumstances the newborn infant has a low supply of oxygen. Diagram b, Chart 1, shows the results obtained in the present study, while c and d portray averages from our earlier studies of deliveries under nitrous oxide and oxygen and under ether. The effects of these have been described briefly at the beginning of this paper. The similarity between diagrams b and c is at once apparent and indicates that the addition of ether did not modify the anoxic effect of nitrous oxide oxygen anesthesia in these patients.

TABLE III.—AVERAGE VOLUMES PER CENT NITROUS OXIDE IN BLOOD AT BIRTH

Anesthetic	Maternal		Fetal	
	Arterial	Venous	Arterial	Venous
Nitrous oxide oxygen and ether	20	21.3	15	20
Nitrous oxide and oxygen	25	2	2.2	9.8

The method of Orcutt and Waters makes possible an accurate measurement of nitrous oxide itself in the blood analyzed. Average figures for the 2 series of deliveries, with and without added ether are presented in Table III. As was expected somewhat more of this substance appeared in the blood of women who received it as their sole anesthetic agent. It is interesting to note however that nitrous oxide was present in the fetal circulation in similar amounts in both series. This might mean that above a certain maternal level increased amounts of nitrous oxide will not pass the placenta, or that the presence of ether influences placental permeability to this gas. In any event, the addition of ether certainly did not seem to lessen the amount of nitrous oxide reaching the fetus in the cases studied. It would be of interest to measure the amount of ether itself in the blood of these infants, and to compare it with the amount present in a series of infants delivered under drop ether anesthesia.

Whenever cord blood was secured for analysis, an attempt was made to describe the promptness of respiration in the infant. The designation, *A* was used for infants breathing and crying strongly at once; those requiring some resuscitation by the obstetrician were graded as *C* and the symbol *B* was used for infants whose behavior was between these 2 extremes. According to this classification the average oxygen levels are presented in Table IV together with similar figures for the 2 anesthetics used separately. Infants delivered under ether showed no correlation between onset of respiration and level of blood oxygen, a fact which presumably indicates the unmeasured narcotizing effect of ether upon the fetal respiratory center. On the other hand a direct relationship between anoxemia and apnea ap-

TABLE IV.—RELATION OF APNEA TO OXYGENATION OF FETAL BLOOD

Type of anesthetic and onset of respiration	Average volumes per cent oxygen in blood	
	Arterial	Venous
Ether		
A	6	
B	5	
C		
Nitrous oxide and oxygen		
A	3	
B		6.5
Nitrous oxide oxygen and ether as A		6
B	5	
C	12	

A, immediate; B, slightly delayed; C, delayed.

peared in those born under nitrous oxide oxygen. The data for nitrous oxide oxygen ether also show such a correlation for the *A* and *B* babies. The one infant requiring resuscitation (*C*) had a very high level of oxygen in the umbilical vein (fetal arterial blood) rather than a low level as might have been anticipated. However this was a breech delivery, the only one in the series, and the mechanical interruption of circulation through the cord for some moments before the birth of the entire infant may have contributed to this anomalous result. Until the head was born the cord was compressed between it and the birth canal. Immediately after the birth of the head, a fresh quantity of blood from the placenta must have filled the umbilical vein, and this composed the specimen obtained. The umbilical arteries in this particular cord were so collapsed that no specimen could be obtained from them, which is a condition usually accompanying fetal anoxemia.

Since it was planned to study unselected hospital deliveries, no attempt was made to prescribe a routine pre anesthetic medication, and a number of different drugs and dosages were administered to the women studied. The most frequent analgesia consisted of 3 grains of secenal and or 2 doses of 1/150 grain each of scopolamine. An attempt to tabulate the relationship of amount of medication with levels of blood oxygen showed no correlation. There was, however a rough agreement be-

tween amount of medication and degree of apnea

The belief that asphyxia neonatorum is constantly associated with profound anoxemia at birth is suggested by the work of Eastman (2) and of Wilson, Torrey, and Johnson. In their studies, measurements of fetal oxygen levels were made upon infants selected as presenting clinical evidence of severe asphyxia. In all instances, a definite anoxemia was found. However, the data presented in Table I, as in the earlier paper from this hospital, indicate that extremely small amounts of oxygen may be found occasionally in the blood of unselected infants presenting slight apnea or none at all. This suggests a surprising capacity of the infant to withstand marked anoxemia, although probably the time factor is of great importance. It is certainly unlikely that the infant can tolerate such situations for more than very brief periods, nor should this evidence be taken to suggest a wide margin of safety in the use of obstetrical anesthesia.

SUMMARY AND CONCLUSIONS

In 28 infants delivered under nitrous oxide, oxygen and ether anesthesia, the oxygen content of umbilical cord blood at the moment of birth was determined. Measurements were made upon samples from the umbilical vein (fetal arterial blood) in all infants and upon samples from the umbilical arteries (fetal venous blood) in all but 2. Simultaneous specimens were obtained from the maternal arm veins in 10 and from the maternal radial artery in 6 instances. Apparently the analyses were sufficiently accurate to be significant although the presence of ether may have resulted in values slightly above the actual oxygen level present, particularly in the maternal specimens.

As compared with results from deliveries under ether anesthesia alone, these mothers

and infants showed a significantly diminished degree of oxygenation. The results were almost identical with those from a series of deliveries under nitrous oxide and oxygen alone.

The infants born under nitrous oxide oxygen and ether had as much nitrous oxide in their blood as did those born under nitrous oxide and oxygen alone, though this gas was present at a lower level in the maternal blood of the former group than of the latter.

Usually, although not always, fetal anoxemia was associated with apnea at birth. Occasionally infants born with such low oxygen levels as 2.6 volumes per cent in the arterial blood, breathed and cried actively at once. In such instances the anoxemia must be only of brief duration.

Judging by the amount of oxygen reaching the fetus at birth, the data presented indicate nitrous oxide and oxygen alone or combined with ether to be a less satisfactory obstetrical anesthesia than ether alone.

The technical assistance of Miss Virginia Nasman is gratefully acknowledged.

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ETIOLOGY AND TREATMENT OF ULCERS OF THE LEG

LEO M. ZIMMERMAN M.D. F.A.C.S. and ADOLPH FALLER, JR., M.D.
Chicago, Illinois

THE history of surgery from its earliest beginnings has been marked by an endless succession of new methods for the cure of chronic ulcers. These remedies, enthusiastically presented, have enjoyed their brief hour of popularity and then have been forgotten together with their predecessors in favor of more recent innovations. With the accelerated rate of change that marks the modern world the stream of new ulcer cures has become vastly augmented in recent years. Each year sees numerous new methods advanced with all the faith and hopefulness that attended the launching of the former methods. The bewildering gamut includes all the fads and fashions of modern medicine, including irradiation with roentgen rays infra-red and ultra violet rays vitamins and hormones internally and locally physical therapy which includes alternate pressure and suction intermittent venous stasis and acetyl-choline iontophoresis to say nothing of the infinite variety of lotions, ointments, and plasters, including of late, those containing urea, allantoin and extracts of maggots. A cursory review of the literature reveals no less than 50 different treatments advocated within the last 2 years for the treatment of leg ulcers. The truth of the old observation that multiplicity of remedies indicates a lack of any really effective one was never better illustrated than in the treatment of ulcers of the leg.

From the welter of changing fashions in the treatment of crural ulcers, one therapeutic fact survives. It has long been found that gentle mechanical pressure is effective in promoting the healing of ulcerating and granulating surfaces. This time honored principle finds application in the treatment of burns, in promoting the survival of skin grafts, as well as in the treatment of ulcers. Its efficacy has been attested to so often clinically and ex-

perimentally that there is no question as to its value. Douglas has shown by actual measurements that the healing rate of chronic ulcers treated by elastic compression is actually more rapid than the previously established ideal rate of healing for recent wounds. In our experience in the peripheral circulatory clinic of Northwestern University Medical School mechanical measures have been the mainstay of our therapy for ulcers and eczemas of venous origin and are relied upon almost to the exclusion of all other forms of treatment. We have come to believe that ulcers of the leg do not, as a rule, constitute a difficult problem and our management of leg ulcers falls into a simple scheme.

ETIOLOGY OF LEG ULCERS

The term leg ulcers, has been used in stead of the conventional varicose ulcers because these lesions are not limited to limbs affected with varicose veins. In fact, the most extensive and refractory ulcers are often found as sequelae to deep vein thrombophlebitis in patients who have minimal or no varicosities. As will be shown later there is no essential difference in pathogenesis, clinical manifestations, or treatment between these and the true varicose ulcers. The term, "phlebotic" or postphlebotic ulcer would more appropriately apply to both groups of lesions.

While specific, neoplastic, and traumatic ulcers do occur on the lower extremities the vast majority of leg ulcers are related to disturbances of the venous circulation. The most familiar are the varicose ulcers and these will be discussed first. The pathogenesis of these lesions is usually ascribed to stasis and to chronic, passive congestion, resulting from impaired venous return due to the varicose veins. We have repeatedly pointed out (3, 4, 5) that this conception is not in accord with many of the facts observed in a study of varicose ulcers. Thus, it is frequently noted that

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there is no parallel whatever between the severity of the varicosities and the incidence and degree of ulcer. Indeed, as has already been mentioned, the most extensive and least tractable ulcers frequently are associated with scarcely recognizable varicosities.

If static, the skin lesions of varicose veins should always be in the most dependent portions of the leg. This, of course, is not always the case. Nor would chronic congestion explain the topographical relationship which exists between the ulcers and the varices. Immediately beneath the cutaneous lesion, large varicose pools may be palpated, or their presence may be demonstrated by infra-red photography, and the long axis of the ulcer usually follows the course of the dilated vessel. It must be obvious that if any chronic, passive congestion occurs as a result of varicose veins, it will affect the tissues in contact with the capillary bed which ultimately drains into the varices and not those structures immediately superjacent to the trunks themselves. Furthermore, areas of induration and pre-ulceration are frequently separated by only a very few millimeters from skin that is perfectly normal in texture and color. It is difficult to reconcile this sharp limitation of the lesions with the wide overlapping of the superficial venous circulation which we know to exist. Finally, in conditions of known chronic passive congestion such as accompanying long standing myocardial decompensation, ulcerations of the type here considered are not encountered.

Against the explanation of chronic passive congestion we have postulated an inflammatory genesis for the cutaneous complications of varicose veins. The complications represent a sequence of changes beginning with phlebitis and pass through the stages of periphlebitis and cutaneous induration to the phlebitis and cutaneous induration to the eventual development of ulcer. Ulcer or ulcer phlebitis is by far the most frequent complication of varicose veins and most patients who have varicosities of any material degree for any considerable period of time experience inflammation sooner or later within segments of the dilated veins. The explanation appears obvious. Due to the static, toxic, and back pressure and degenerative changes of the

intima within the varicose veins, these vessels constitute a site of predilection for circulating organisms. Bacteria reaching the blood stream from infected distant foci or in the course of intercurrent infections tend to localize in the varices. Frequently, latent infection is present and becomes activated from time to time by slight trauma, after operation, debility, or general indisposition. The inflamed vein segment appears as a dull red, firm, slightly tender cord. Constitutional symptoms are mild or absent. The process appears, runs its subacute course, and subsides to reappear at intervals in the same or different segments of the varicose veins.

The second stage in the genesis of the cutaneous complications of varicose veins is the development of the so called periphlebitic indurations. The inflammatory process, which at first was localized to the vessel wall, ultimately extends to the adjacent skin and subcutaneous tissues. This results in a circumscribed area of low grade cellulitis. These round or oval patches appear in their active stages as dull red, indurated, warm, and slightly tender plaques. As the inflammation subsides, the vein which gave rise to it can often be palpated as a trough or channel coursing through the indurated perivenous tissues. The cycle of recurrence and subsidence is usually repeated, each episode leaves more and more permanent, irreversible changes in the skin and subcutaneous structures. These consist of pigmentation, induration, atrophy, cicatrization, and fixation to the subjacent tissues. The familiar woody, brown or mahogany color indurations are produced in which there is ischemia from scar tissue contraction with resulting impairment of resistance and reparative capacity. Slight abrasions or contusions to such areas give rise to ulcers which tend to spread and which may display little tendency toward healing. Secondary infection from without adds to the tissue damage and makes for further chronicity thus completing the vicious circle.

Ulcers follow a deep or phlebitic. The second great cause of crural ulcers is thrombophlebitis of the deep veins. The sequence of events in the evolution of this type of lesion is much more difficult to follow than in the

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phlebotic indurations, and varicose eczemas. We recognize that the same principle of elastic pressure may be achieved by other measures, such as elastic adhesive bandages, elastic bandages with rubber sponge dressings, and various types of paste-impregnated bandages. We have used some of these preparations with considerable satisfaction but, since we have had wider experience with the Unna boot than with all other forms of pressure bandage, we shall limit our discussion to this measure alone.

The Unna paste boot has proved so regularly effective in our experience in the treatment of leg ulcers that it is difficult for us to understand its very limited use in general medical practice. We have often made the statement, and advisedly, that no other therapeutic measure at our command, other than an injection of morphine, so regularly yields the desired results as does Unna's paste boot. The unbearable pain rapidly subsides, the edema disappears, the exudate diminishes in amount and the indolent, necrotic, unhealthy ulcer base is quickly converted into healthy, firm, red, granulation tissue. The vast majority of ulcers progress uninterruptedly to complete healing without recourse to further therapeutic agents.

Occasionally, in long standing, callous ulcers, after the usual initial rapid improvement, the tempo slows, and eventually a stage may be reached in which no progress can be seen from one change of boot to the next. Under these circumstances, renewed stimulus may be obtained by strapping the ulcer with strips of adhesive tape and by applying the boot over the strapping. This time honored, simple expedient is surprisingly effective both in the production of granulations and the hastening of epithelization. If in time this stimulus also wears off before the ulcer is entirely healed, further acceleration may be secured by applying pads of rubber sponge under the boots. These are of particular value in deep punched out ulcers in that they apply elastic pressure to the floor of the defects.

Technique. Unna's paste may be purchased commercially or if large quantities are used can perhaps be prepared more economically by the pharmacist or nursing staff. The tech-

nique of preparation is not difficult. Our method is as follows:

Zinc oxide, 1 part
Gelatine, 2 parts
Glycerine, 3 parts
Water, 4 parts

Heat glycerine until steaming and then add gelatin slowly and stir it in. Then add water and stir as it is being added. Heat mixture to boiling. Pour over zinc oxide powder in jar and stir until cool. Cut into 6 ounce lumps and wrap in waxed paper.

When the boot is applied, the quantity needed is melted in a water bath. The paste should be fluid enough for smooth application with a brush and not too hot for safety or comfort to the skin. A layer of paste is painted on the surface of the ulcer as well as that of the normal integument, and extended from the base of the toes to the knee. If the ulcer involves the submalleolar region, it is frequently advisable to include the heel in the boot. A layer of gauze bandage of sufficient thickness to give body to the boot is then wrapped about the limb. Great care must be taken to avoid twists or creases in the bandage, since pressure or constriction to the indurated areas may be sufficient to produce a new ulcer. To obviate this danger, students in the clinic are taught to cut each successive turn of bandage, and so insure a perfectly smooth wrapping. Over this bandage another layer of paste is painted and then covered with a second thickness of bandage. Adhesive strips are applied in spiral fashion to keep the bandage from slipping.

As a rule the boots are changed once a week at first. Later, when edema has subsided and the amount of exudate has diminished, they may be left on for 2 or 3 weeks or longer. If the drainage is exceptionally profuse, they may require changing twice weekly. It is important to caution against having the boots removed at home since recrudescence of swelling militates against prompt healing. Patients are instructed to return with boots on. They are removed in the clinic and the limbs are bathed with soap and water, dried and the new boot is applied. When healing is complete further protection with Unna's paste or elastic bandages for several weeks longer is advised until the scar is sufficiently

varicose ulcer and several of the steps are as yet unexplained. Apparently the initial phenomenon in these cases is thrombophlebitis of the femoral or iliac veins. Such deep vein inflammations occur characteristically as puerperal phlegmasia alba dolens" or as complications following operations. In addition to general symptoms and local evidences of inflammation edema of the extremity is a typical manifestation of impaired venous return. The edema disappears in the milder cases to recur for a short time when the patient begins to be up and about. In more severe involvements the edema may persist for months and it sometimes remains permanently.

Several types of complications may be engrafted upon the chronically edematous limb of the patient who has had deep vein phlebitis. In some recurring attacks of an erysipelas-like infection of streptococcal origin sweep over the limb with attendant symptoms of acute toxemia and leave in their wake increasing amounts of subcutaneous fibrosis. In time a true elephantiasis may develop. The skin of the involved extremity may become thickened discolored and leathery and its surface may be roughened fissured and eczematous.

A more frequent type of late complication is the development of plaques of inflammation and induration in the skin and subcutaneous tissues which resemble those appearing about varicose veins. However no large venous channels can be demonstrated coursing through these indurations. In the absence of any other convincing explanation as to the genesis of these indurated areas, we have assumed that they begin as phlebitides involving the smaller superficial veins.

Whether or not this explanation is the correct one is not certain but once they are formed the clinical course of these indurations is identical with that described for the lesions developing about varicose veins. They tend to be more extensive however to develop more rapidly and occasion a greater crippling of the tissues than is usually seen following varicose vein infections. Ulcers develop on the basis of these indurations just as they do on those described earlier except that they

are more extensive and disabling and less amenable to treatment than are the ordinary varicose ulcers. When indeed ulcerations occur that are out of all proportion to underlying varicosities, it can be assumed almost always that they are the sequelae of deep vein inflammations.

Thus, the vast majority of leg ulcers are associated with diseases of the veins. Whether due to varicose veins or to deep thrombophlebitis, they are essentially infectious in origin and develop on the basis of periphlebitic infiltration and clottrization. They are similar in pathogenesis and clinical manifestations and respond to similar forms of therapy. The essential, predisposing pathological change is ischemia from inflammatory sclerosis of the skin and subcutaneous tissues. Secondary infection from without adds to the fibrosis and circulatory insufficiency. Although disease of the veins constitutes the initial step in the genesis of these lesions, the tissue changes are permanent and irreversible and the ulcers may persist or continue to evolve even after complete eradication of the associated varicosities.

TREATMENT OF CRURAL ULCERS

As was stated before our management of leg ulcers falls into a simple scheme in which the use of mechanical pressure is the mainstay. It must be emphasized that the treatment is almost invariably ambulant bed rest and elevation are rarely found necessary. The patients are for the most part, working people and they are permitted to go about their usual affairs without restriction so long as the pressure bandages are in place. Indeed, we have succeeded not infrequently in healing ulcers by ambulant treatment after prolonged bed rest had failed. Recumbent management is limited to the small group of cases to be described later which do not tolerate occlusive dressings of any type and to those with acute infection severe enough to demand bed rest.

For obtaining gentle elastic pressure we have come to rely almost exclusively upon Unna's paste boot, not only for the treatment of ulcers but also for other complications of varicose veins including local phlebitis.

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firm and tough. Postthrombophlebotic limbs with persisting edema may require permanent supportive bandaging to prevent swelling and tendency to ulcerate further.

TREATMENT OF ASSOCIATED VARICOSE VEINS

Eradication of concomitant varicosities is, of course, an integral part of the management of patients with varicose ulcers. It is our opinion however that the significance of obliteration of varicosities for the healing of ulcers is greatly exaggerated. The literature contains many reports of prompt healing of chronic, intractable ulcers, following the injection of varicose veins. Leriche has recently removed several cases from the category of varicose ulcers because the ulcers recurred in spite of complete extirpation of the varicosities.

From what has been said regarding the pathogenesis of ulcers which are associated with varicose veins, it is perfectly obvious that once the tissue changes which lead to ulceration have become established they will persist irrespective of what is done to the varicose veins. Treatment of the ulcer resolves itself into the healing of an ischemic lesion in a zone of inflammatory sclerosis. The rationale of treatment of associated varicosities is largely the prophylaxis against further inflammation with subsequent increasing fibrosis, by interrupting the cycle of pathological changes. When the varices are eliminated recurrence of phlebitis and consequent increase in the crippling of the surrounding skin is largely prevented. Nevertheless, if the tissues have become sufficiently devitalized, recurrences of the ulcers may continue to develop even after all varices have been removed.

Because ulcers are always infected with a multiplicity of organisms and because they are often acutely inflamed when first seen we usually defer active attack upon the veins for several weeks. Unna's boot therapy is carried out as described until the inflammation has subsided and healing is in progress. Obliteration of the varicosities is then very cautiously undertaken. It is begun with a minimal degree of irritation to avoid a flare-up of the phlebitis.

Our management of the varicose veins consists of ligation and injection comparable in all essentials to that reported by other writers in the field. The almost universal unanimity of opinion as to the treatment of varicose veins speaks eloquently for the efficacy of modern management. We do preliminary ligation in all cases with material degrees of tension within the varicosities and in which reflux is demonstrable by the Trendelenburg test, from the saphenofemoral junction downward. We advocate high ligation and division of the long saphenous vein with retrograde injection of sclerosing fluid into the distal vein segment. This is followed by ambulant injections until all varices are obliterated. Our choice of sclerosing solution has run the gamut, and we are now using soaps of the fatty acids—sodium morrhuate, potassium oleate or sodium ricinoleate—as the most satisfactory of any that have as yet been tried.

OTHER THERAPEUTIC MEASURES

As has been stated, most ulcers of the leg respond promptly to the simple scheme of management outlined and do not constitute difficult problems. In exceptional cases difficulties may arise which require adjuvant measures. No mention is made of ointments, and indeed ointments play a very small rôle in our management of ulcer patients. If the exudate is particularly profuse and if it becomes excessively malodorous from saprophytic infection, a mild and bland antiseptic ointment applied to the surface of the ulcer and incorporated in the Unna boot will inhibit the growth of these organisms and greatly reduce the odor. For this purpose we usually use a 2 per cent mercurochrome ointment in equal parts of lanolin and vaseline or some similar simple preparation. Likewise, a bland protective ointment is occasionally applied to inflamed and irritated skin adjacent to an ulcer although, as a rule, Unna's paste is painted directly on the surface in static dermatoses and eczemas. During the initial stages, which may be acutely painful, ointments containing local anesthetic preparations such as nupercaine, benzocaine or butyn often give prompt relief. If there is

co-existing ring worm infection, painting with gentian violet or a similar antiseptic application is indicated

An interesting and sometimes perplexing problem is presented by the patient who is apparently sensitive to the exudate from his own lesion. In this type of so called "eczematid" reaction, no type of occlusive dressing is tolerated, and retention of the exudate may give rise to local or general disturbances. Locally, the exudate is apparently caustic and provokes progressive scalding and irritation of the skin with attendant severe itching and burning. Severe, systemic, allergic reactions are seen occasionally. One patient with very moderate ulceration of both legs became violently ill following the application of Unna's paste boots, with nausea, vomiting, hematuria, fever, edema of the face and hands, and generalized pruritic cutaneous eruption. The most severe changes were in the areas covered by the boots. The skin of both legs was completely covered with massive hemorrhagic blebs. To rule out sensitivity to the materials in the paste, patch tests were done with the various constituents of the paste and with the paste itself with totally negative results.

Such general reactions on an eczematid basis are rare, but local intolerance to the exudate is relatively common. When this intolerance is present, aggravation of the dermatitis follows any type of occlusive dressing. In such instances we customarily use moist compresses of aluminum subacetate until the eczema is healed and the exudation has ceased. This frequently entails recumbent treatment and constitutes one of the few exceptions to ambulant management of patients with ulcers and eczemas of lower extremities.

Coincident general disease may be an important factor in delaying the healing of ulcers and must, therefore, be recognized and adequately treated. Syphilis, of course, must be ruled out by serological as well as clinical tests, and, if present, must be appropriately combatted in addition to the local management of the ulcer. In such cases mercury ointment may be applied directly to the ulcer and incorporated within the paste boot. Similarly, diabetes, anemia, malnutrition,

and vitamin deficiency, and specific infections must receive due consideration.

Of all the general conditions militating against the healing of ulcers, perhaps the most important is arteriosclerosis with peripheral arterial ischemia. As has been emphasized, the essential lesion in chronic ulcer is cicatricial ischemia. The more extensive the fibrosis surrounding an ulcer, the poorer the circulation and the slower the healing. If there is general peripheral circulatory insufficiency superimposed upon the local ischemia, healing becomes increasingly more difficult or even impossible. Concomitant diabetes may further add to the problem. We have had to admit defeat in a small number of cases falling into this group, and have even had recourse to thigh amputation because of disabling, intractable, bone-involving ulcers that resisted all other forms of treatment. In general, when excessive degrees of arterial insufficiency are present, because of local or general causes, or both, the usual expedients for increasing local arterial circulation must be added to the simple supportive measures required for the ordinary case. These will include suction-pressure treatment, intermittent venous stasis, and iontophoresis with acetylcholine derivatives.

Skin grafts. On the basis of our conception of the pathogenesis of leg ulcers, skin grafting should find an important place in the management of these lesions. If the condition is due not to chronic passive congestion, which would affect all of the tissues of the extremity and jeopardize the "taking" of the graft, but to local inflammatory changes of the skin and subcutaneous tissues with normal circulation in the adjacent structures, excision of the pathologically altered tissues and replacement with full thickness grafts would be a logical solution to the problem. We have no doubt that this is really the case. Such management, however, would necessitate bed rest and hospitalization for a number of weeks, both for preparing the field for operation and for healing of the grafts. Because of our almost universally satisfactory results with the purely ambulant management of ulcer cases, we have had very little recourse to operative methods.

Skin grafts on ambulant patients whether by the Thiersch or pinch graft method are usually disappointing. The exudate is usually profuse enough to float the graft from the surface and the transplant fails to take. We have had some success with pinch grafts buried in the granulations of slow chronic ulcers, but, in general skin grafting has not played an important part in our management of leg ulcers.

SUMMARY

Most ulcers of the leg are associated with disturbances of the venous circulation. The two principal underlying conditions are varicose veins and deep vein thrombophlebitis. The cutaneous lesions are usually ascribed to chronic passive congestion occasioned by the vein disease.

This explanation cannot be reconciled with the many facts which are revealed in a clinical study of these conditions. They seem rather to be inflammatory in origin and a sequence of events may be traced from initial phlebitis through the stages of induration and cicatrization to the eventual ulcers. Both groups of ulcers therefore are phlebitic in

origin and the essential tissue change in both is inflammation with subsequent fibrosis and cicatricial ischemia.

Of the innumerable remedies offered for ulcers of the leg gentle mechanical pressure has proved most effectual and in our clinic, provides the mainstay of our therapeutic regimen. Eradication of concomitant varicoses and attention to associated local and general conditions are also included. While skin grafts are theoretically a logical solution we rarely have recourse to them because of the satisfactory results obtained by purely ambulant methods.

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THE PRODUCTION OF EXPERIMENTAL ACUTE APPENDICITIS (WITH RUPTURE) IN HIGHER APES BY LUMINAL OBSTRUCTION

OWEN H. WANGENSTEEN, M.D., F.A.C.S., and CLARENCE DENNIS, M.D.,
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OBSERVATIONS made on the vermiform process of man and the cecal appendage of the rabbit indicate that this segment of the intestinal canal secretes fluid. In a large number of common domestic and laboratory animals, no evidence of secretion of fluid was obtained when the cecal appendage was obstructed. Obstruction of the vermiform appendix of man and of the cecal appendage of the rabbit resulted in the production of a histological picture very similar to that of spontaneous appendicitis in man.

These considerations suggested that it would be interesting to study the secretory capacity of the vermiform appendix in anthropoids—the only family, other than the human, in which a true vermiform process occurs. For the purposes of this study three chimpanzees (*Anthropopithecus troglodytes*) and two howling golden gibbons (*Hylobates entelloides*) were available.

TECHNIQUE

Anesthesia The animals were anesthetized primarily with ether, a copy of the anesthesia box described by Elder from Fulton's Laboratory (7)¹ was used. As soon as possible, sufficient sodium amytal was given intraperitoneally to provide surgical anesthesia (usually about 35 milligrams per kilogram of body weight).

Surgery With strict aseptic technique, a right rectus incision was made, and the cecum and appendix were delivered. After the tip had been amputated for control section, and after cultures had been made from the lumen,

a cannula of glass was inserted and tied with No. 30 commercial linen. Physiological tests were made on the appendix and the base was tied with linen, and the region was walled off from the rest of the abdominal cavity by silk sutures attaching the cecum to the anterior abdominal wall in a circle about the base of the appendix. Further physiological tests were made, including the determination of the volume-elasticity, or the luminal capacity of the appendix at certain pressures from zero to 100 centimeters of water. The wound was closed with the appendix and mesoappendix coming out through it, dressed outside the skin in vaseline gauze.

Recording The cannula was connected to a recording mercury manometer of such proportions that 0.55 cubic centimeters of fluid had to be forced into the cannula from the appendix to raise the pressure reading from 0 to 100 centimeters of water. It was with this that we determined the volume-elasticity, using a one cubic centimeter tuberculin syringe connected to the closed appendix-manometer system by a T-tube and making volume corrections for the manometer. The pressure recording was started at atmospheric pressure.

Care of the animal during recording Preliminary tests with dogs had shown that with prolonged anesthesia under amytal, the required dosage is about one-sixth of the initial dose per hour for the first half-day, thereafter gradually diminishing. An electrically driven syringe was usually used to force this dosage continuously into the subcutaneous tissues of the thigh. Preliminary experiments with dogs had shown also that change of position every few hours is necessary to prevent the development of pneumonia, if anesthesia is to be maintained over a prolonged period, and, for

From the Department of Surgery, University of Minnesota Medical School, Minneapolis.

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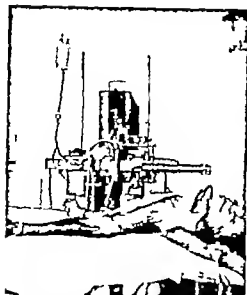


Fig. a. General arrangement of animal and apparatus for recording pressure changes. The tube from the elevated intravascular flask is doubly clamped during the recording of the spontaneous rise of intraluminal pressure.
b. Another view showing the general arrangement of the apparatus for the recording of spontaneous pressure rise when the chimpanzee appendix. The thermosatically controlled temperature box has been placed over the animal

this reason, the position of the apes was changed every 4 hours. The studies on dogs had shown also that the prevention of pneumonia required the maintenance of normal body temperature and that at this time of year (November and December) maintenance of a constant environmental temperature of 29 degrees C resulted in an almost constant body temperature of 37.5 to 38 degrees C under continuous amylal anesthesia. A thermosatically controlled temperature box was therefore constructed to fit over the operating table.

During the recording temperature respirations, pulse depth of anesthesia, volume of urine, and specific gravity of urine were recorded. We administered subcutaneous fluids as dictated by the urinary findings, using alternately 0.9 per cent sodium chloride and 5 per cent glucose solutions. The general arrangement of the apparatus which we used is indicated in Figure 1.

FINDINGS

Three chimpanzees and two gibbons were used in this study, the chimpanzees being 0

to 12 months of age and having a sitting height of 15 to 20 inches and the gibbons being 4 to 7 years old and about the same size.¹ Four animals were in excellent health but one chimpanzee (No. 2) proved at operation to have an extensive tuberculosis both of the mediastinum and bowel which contributed to his death prior to the completion of the planned procedures.

Chimpanzees. Anatomical and physiological observations. The anatomy of the appendical region agreed with the reports of Reider and of Kelly and Hurdon. The appendicocolic junction in each case was of Treves's type II, the length averaging 1 centimeters (extremes 7 and 15 centimeters) and the diameters averaging 5 millimeters. In each case although the appendix was similar in form to the usually observed human type II organ, it was impossible to straighten it out completely because of the inadequacy of the mesentery. It was noteworthy from the point of view of the purposes of our experiments

¹The authors wish to express their gratitude to Mr. Paul M. Traut, commissioner of parks, playgrounds, and public buildings of the city of St. Paul for his generous promise of the facilities of the Como Park Zoo, and for the available assistance of his staff in the care and handling of our animals.

TABLE I — VOLUME ELASTICITIES

Chimpanzee 1		Chimpanzee 2		Chimpanzee 3	
Pressure cm water	Volume c cm	Pressure	Volume	Pressure	Volume
0	0	0	0	0	0
20	0	20	0	20	0.01
40	0	40	0	40	0.01
60	0.07	60	0.28	60	0.01
80		80	0.50	80	0.11
100	0.15	100	0.70	100	0.13

(Limit of accuracy approx 0.01 c cm)

that in each case the large blood vessels in the mesentery lay near the free edge, in no case near the appendix itself. Figure 2 shows the appendix of chimpanzee 3.

Cultures of the lumina of these organs showed almost every organism one could expect to find within the main lumen of the intestinal tract. The organisms reported included the following: *Aerogenes*, *Bacillus welchii*, Gram-positive spore formers, *Escherichia coli communis*, pleomorphic Gram-positive rods, streptococci, Gram-positive diphtheroids, and staphylococci.

Microscopic sections of the amputated tips of these appendixes were essentially normal. One section showed polymorphonuclear neutrophils just under the mucosal epithelium, in the epithelium, and also nearby in the lumen, calling to mind the observations of Isaacs and Danielian and of Jassinowsky and his co-workers concerning the passage of aged white blood cells through the intestinal epithelium as a normal mode of final disposition of these cells (Figs 3a and 3b).

Following the placing of the cannula and prior to the ligation of the appendical base, the resistance which the appendix offered to the flow of fluid through it into the cecum (to which we have applied the term "absolute resistance to outflow") was determined, by means of the manometer already mentioned and a source of fluid more than a meter above the appendix, the rate of flow being adjusted with the aid of a screw clamp and a gravity drip bulb. Because of the variety of tests undertaken, not all could be performed on any one animal. In the second chimpanzee the appendix sustained a column of fluid 53 centimeters high, in the third 35 centimeters high, thus averaging very slightly higher than the normal human average of 38 centimeters



Fig 2 Photograph of the cecum and appendix of a chimpanzee taken immediately after delivery from the wound.

previously reported (13). In animal 2, when the rate of flow was adjusted to 30 drops per minute, the resistance to outflow was 80 centimeters of water. In animal 3, the resistance at 10 drops per minute was about 42 centimeters of water, with peaks coming every 15 to 30 seconds and rising as high as 50 to 70 centimeters of water, findings identical to those in normal man. Stimulation of the appendical wall was performed in these same animals, by means of Faradic stimulation coming from a Harvard inductorium with the secondary coil at 7 centimeters and the primary supplied by two dry cells in series, a stimulus just sufficient to be felt with the finger. Stimulation of the wall caused a strong ring of contraction which raised the pressure required to keep a constant flow (Fig 5).

The volume-elasticity in the first and third animals was 15 and 13 hundredths of one cubic centimeter at 100 centimeters pressure, respectively, and in the second it was 70 hundredths. The volume elasticities are given in Table I.

The presence of muscular tonus was demonstrated not only in the rhythmic variations in resistance to outflow already mentioned, but also in chimpanzee 1 by the fact that when the pressure was reduced to zero without withdrawing all the fluid, the pressure then rose in a few seconds to 5 to 6 centimeters of water, where it remained. When about 0.07 cubic centimeters was run into this organ and the syringe tube was clamped, there shortly appeared rhythmic variations in pressure between 55 and 62

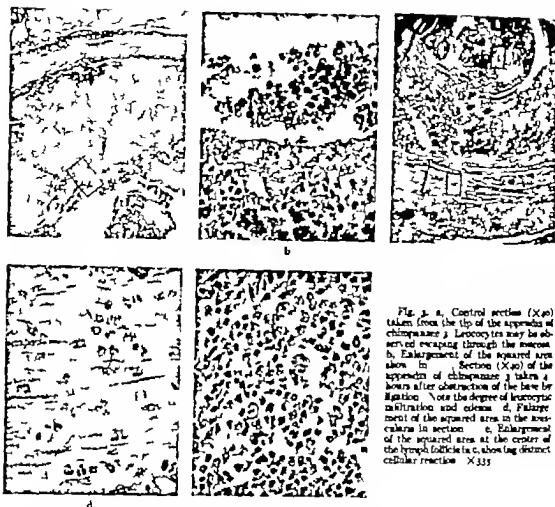


Fig. 3. a, Control section (X40) taken from the tip of the appendix of chimpanzee 3. Leucocytes may be observed escaping through the mesoca. b, Enlargement of the squared area shown in Section (X40) of the appendix of chimpanzee 3 taken 4 hours after obstruction of the base by ligation. Note the degree of leucocytic infiltration and edema. c, Enlargement of the squared area in the mesocolon in section. d, Enlargement of the squared area at the center of the lymph follicle in c, showing distinct cellular reaction. X335.

centimeters of water pressure coming every 20 to 30 seconds indicating rhythmic muscular activity.

Measurement of intraluminal pressure changes after obstruction of the appendical base in the chimpanzee. In all 3 experiments when the appendix manometer was made a closed system, a rise in pressure occurred. The amount of this rise in pressure and the time relationships are indicated in the charts in Figure 4. In chimpanzee 1 the pressure rose to 70 centimeters of water in 30 hours and 40 minutes, at which time rupture occurred. In the second animal the experiment was terminated by accidental death indirectly due to pulmonary tuberculosis at 10 hours at this

time the pressure had already reached a height of 42 centimeters. In the third, the pressure rose to 106 centimeters in 39 hours and remained there 3 hours, when rupture occurred. In the surviving animals appendectomy was done without opening the peritoneum and both recovered.

In chimpanzee 1 a final volume elasticity determination was done at the conclusion of the pressure recording (Table II). At 80 centimeters leakage was first observed along the mesenteric border both in the area which had been beneath the skin and in that which had been outside. It is evident a stretching of the appendical wall took place during recording when intraluminal pressure was rising

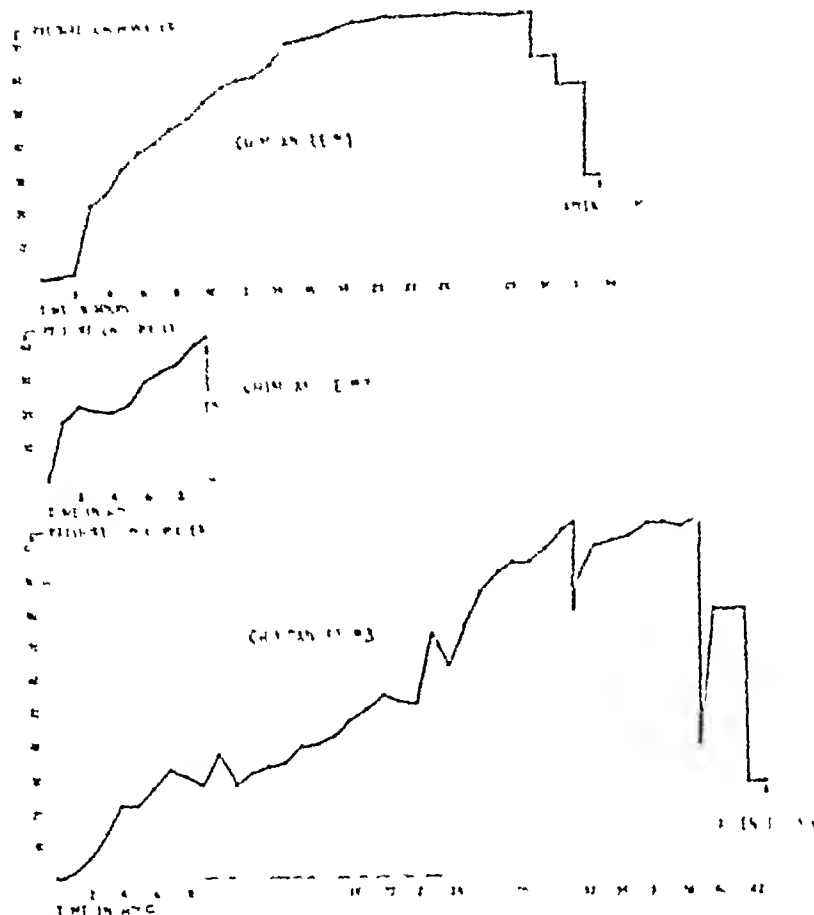


Fig. 4. Charts transposed from the kymographic records indicating the time relationship of the pressure rise within the lumen of the three obstructed chimpanzee appendices.

Microscopic changes resulting from spontaneous rises in pressure after ligation of the base of the chimpanzee appendix. Microscopic examination of the appendices of all 5 animals showed diffuse appendicitis. In animal 1 sections were also taken from beneath the skin to avoid as much as possible the serosal reaction observed in the distal portion. This proximal section showed polymorphonuclear infiltration of all the layers, predominantly the mucosal and muscular layers, with lesser involvement also of the serosal layer. In the third animal examination showed rupture, edema, necrosis, and polymorphonuclear leukocytic infiltration of all the layers, primarily in the mucosa and muscularis, with pus in the

lumen and distally disappearance of portions of the mucosa. The serosal reaction was considerable distally but minimal in the portion of the appendix which had been beneath the skin (see Figs. 35, 36 and 37).

Gibbons. Anatomical and physiological observations. In both gibbons the cecum and

TABLE II—TENSILE VOLUME ELASTICITY
CHIMPANZEE 1

Pressure cm. water	Volume appendix ccm.
0	0
10	0.10
20	0.60
30	0.90
40	1.00
60	1.15
90	Leakage

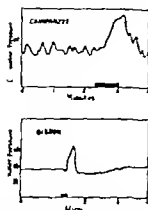


Fig. 5. Tracing of kymograph record showing first, above, the curve of rhythmic variations in pressure required to keep constant slow flow passing through the appendix into the cecum. At the point indicated by the heavy horizontal bar Faradic stimulation was applied through previously placed electrode to the wall of the appendix. The lower figure shows the absence of rhythmic variations in the gibbon, but response to stimulation.

appendix lay free in the peritoneal cavity and were readily delivered. In both cases the appendix was of Treves's type I or infantile form and the three tennae continued from the cecum down onto the appendix for about half its length. The first appendix was 12 centimeters long and 8 to 10 millimeters in outside diameter; the second was 7½ centimeters long and of uniform 6 millimeter diameter throughout except for the bulbous end which was over 8 millimeters in diameter. The wall was found to be much thinner than that of the average human and the internal diameter therefore larger. Cultures from the lumina showed the same multiplicity of organisms found in the chimpanzees.

The absolute resistance to outflow was determined in one animal and was 31 centimeters of water. When a flow of fluid at 40 drops per minute passed the pressure re-

quired was about 39 centimeters of water and there were no waves in the curve a point in contrast both to the chimpanzee and man upon Faradic stimulation, however a rapid response was obtained as shown in Figure 5.

The volume elasticity was determined partially in each animal, and the values are shown in Table III.

The determination was not carried to higher levels in gibbon 2 because the organ was beginning to look extremely distended.

Measurement of intraluminal pressure changes after obstruction of the appendiceal base in the gibbon. The pressure recording lasted for 48½ hours in one animal and 22 in the other; the course of the changes is shown in Figure 6. In the first animal the pressure was artificially reduced to zero at 16 hours because it was feared the elevation present until that time might be due to fluid left after the initial physiological tests, which proved to be true for the level did not rise again. In neither case was there elevation above the intraperitoneal pressure of 6 to 7 centimeters of water except in the first few hours.

Microscopic examination after the recording experiments. Microscopic examinations were made of the tip at the start and of the midpoint at the end of each experiment. The final sections differed from the initial ones only in mild serositis (from handling). The configuration was in many respects similar to that of the human appendix, but the wall was thinner with the muscularis 150 micra thick and the mucosal and lymphoid layer about 900 micra thick (Fig. 7).

EVALUATION

It has been shown that the appendices of the 3 chimpanzees studied resembled that of man in many respects grossly, microscopi-



Fig. 6. Charts transposed from the kymographic records indicating the time relationships of the pressure changes within the lumina of the two obstructed gibbon appendices.

TABLE III — VOLUME-ELASTICITY

Gibbon 1		Gibbon 2	
Pressure cm water	Volume c cm	Pressure	Volume
0	0	0	0
20		20	0.01
40		30	0.79
60			
80	2.1		

cally, as regards the luminal volume with various pressures (13), in reference to rhythmic contractions (1, 13), and in ability to form strong contraction rings upon Faradic stimulation locally (1). In chimpanzee 3 the absence of waves in the resistance to outflow with no fluid flowing (absolute resistance to outflow), the demonstration of strong contractile ability in the general wall of the appendix by Faradic stimulation, and the rhythmic variations in pressure required to keep a constant flow through the appendix into the cecum are all facts strongly suggesting that in this animal the situation is as found in man, in whom there is no apparent anatomically functioning sphincter mechanism at the base of the appendix, the resistance to flow being produced by all segments of the organ alike (1, 13). Finally it has been shown that the appendixes of 3 chimpanzees secreted fluid enough in excess over any possible absorption to build a pressure within the obstructed lumen, with development of acute inflammation of the wall, as has been shown elsewhere to occur in man (14).

In the gibbons studied, on the other hand, the resemblance of the appendixes to that of man was less marked. They were of the infantile type I of Treves, and had a much larger luminal volume at the same pressures than either the human or chimpanzee appendix. One lacked rhythmic variations in resistance to flow of fluid through it, though it presented an absolute resistance to outflow not greatly different from the 2 others, and contracted quickly on Faradic stimulation. Finally, and this is the essential difference from the point of view of the present study, both failed to secrete fluid sufficiently to elevate the pressure when obstructed, and the gibbons consequently did not develop appendicitis following obstruction. These 2 experiments therefore serve as excellent controls for the chimpanzee experiments and show



Fig 7 Section of the appendix of gibbon 2 after 22 hours of recording in which no significant rise in pressure occurred. Note the essentially normal microscopic picture, save for serosal reaction. $\times 40$

that the elevation of pressure was the essential factor in inciting the acute response there. It would, of course, be very interesting to obstruct the base of the gibbon's vermiform appendix and return it to the peritoneal cavity to note whether delayed rupture might occur. We hope sometime to do this.¹

The purpose of these experiments was fulfilled in that, in contrast to what one may do in man, the process here was allowed to progress. Rupture occurred in the acutely inflamed appendixes of both the chimpanzees which survived long enough.

Acute appendicitis has been shown to be capable of production in milder forms by obstruction of the lumen in man, and in more severe forms by the same mechanism in the chimpanzee, in which the experimenter may let the process progress to gangrene and perforation. Therefore, it is logical to conclude that the severe advanced forms would also result in man if the process were allowed to continue for long intervals after obstruction of the base.

CONCLUSIONS

1 Anatomically and physiologically, the vermiform appendix of the chimpanzee has

¹We have been fortunate in receiving several chimpanzee specimens from Dr. George Barnett of Chicago and from Dr. J. F. Fulton of New Haven. Recently Dr. C. R. Schroeder of San Diego sent us the vermiform appendix and cecum of an orang-outang. It falls into Treves type 1 classification. We have yet had no opportunity to determine the secretory capacity of obstructed appendix of gorilla or orang-outang.

CLINICAL SURGERY

FROM THE JAMES BUCHANAN BRADY UROLOGICAL INSTITUTE

RADICAL CURE OF HYDROCELE BY EXCISION OF SEROUS LAYER OF SAC

HUGH H. YOUNG, M.D., F.A.C.S., Baltimore, Maryland

THE treatment of hydrocele has been the subject of numerous reports in the literature in recent years, the tendency has been to avoid radically curative operations. This has gone, *pari passu*, with attempts to cure inguinal hernia by injection treatment, and even great prostatic hypertrophy by transurethral operations. The simple procedure of tapping has been used from time immemorial but requires frequent repetition, and in employing it one is always confronted with the hazard of infection. Recently I have seen one such case in which a large hydrocele had been tapped six times and, on the seventh, a fulminating infection resulted not only of sac but of subcutaneous tissues. Patient narrowly escaped serious consequences.

Aspiration, followed by the injection of some strong irritant to put an end to the reaccumulation of fluid, has been tried for years, and numerous substances have been used for the injection. In many cases in which this procedure was "successful," dense adhesions formed between the tunica vaginalis and the tunica albuginea covering the epididymis and testicle, occasionally leading to contractures that were painful. On other occasions small lobulated accumulations of fluid recurred between the epididymis and the testicle and tunica vaginalis, resulting in areas of marked tenderness and sometimes considerable pain. In some cases fine string like adhesions were present between the epididymis and testicle, which as the fluid recurred, produced points of tension between the testicle and epididymis that were painful in character. The multiplicity of substances which have been proposed from year to year for the injection treatment of hydrocele are evidence of the unsatisfactory results.

The open operation has been the method preferred by surgeons in the majority of cases, whereas non-surgical practitioners have been prone to employ aspiration or injection. Statistics are at

hand to show that excision of the sac is the most radically curative method, but the great vascularity of the thick walls of the sac, especially after sudden emptying of its contents and resulting engorgement of the vessels, has made the operation difficult. To avoid this, Winkelman advised only partial excision of the sac and inversion of the remaining portion, the edges of which were approximated posterior to the epididymis. Andrews' bottle operation, which consisted merely of opening the sac and turning it inside out and suturing behind the epididymis is a simple procedure, but leaves a large mass of tissue back of the testicle. It also has the disadvantage of being more frequently followed by recurrence than the operation of excision. The necessity of meticulous clamping and ligature of all bleeding points, and the proneness to occasional extravasations amounting at times to huge blood clots in the scrotum, have militated against the popularity of the excision operation, and are considerably responsible for the numerous attempts to devise curative methods by simple aspiration. As mentioned, although numerous substances have been tried, recurrence after the aspiration-injection treatment is far too high, and occasionally results in painful conditions.

For many years I have been an advocate of the open operation and have employed excision of the sac with its several coats. Great care was taken to ligate all bleeding points. The difficulty of accomplishing this, and the occurrence of a large hematoma caused me to use the bottle operation for a number of years, but I rarely was satisfied with the results.

A NEW SIMPLIFIED RADICAL OPERATION FOR HYDROCELE

Several years ago, in a case of hydrocele, I discovered, after incising the skin, subcutaneous tissue, and the dartos of the scrotum and after

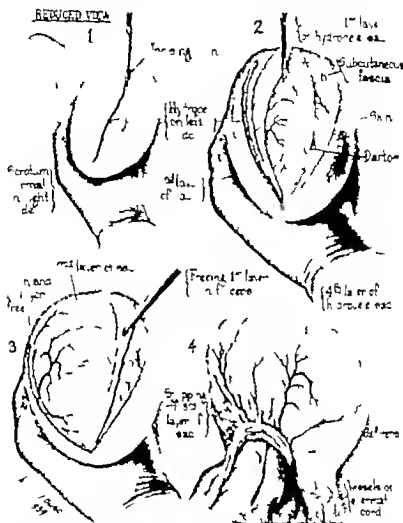


Fig. Author's operation for hydrocelectomy (vaghilectomy). Incision through skin from upper to lower end of hydrocele 2. In thirteen the natural skin—skin, subcutaneous fascia, and dartos has long been factored, the scrotum is lacking the first layer of the hydrocele sac which is then stripped back, 3. The second layer is similarly incised, and the third, which is then stripped back to the pedicle, thus exposing the fourth layer 4. These layers are of extreme thickness, but can be easily divided and stripped from each other. (BUI 26837)

delivering the hydrocele sac, that by delicately incising the outer coat at full length, layer after layer could be peeled back until finally only the serosa remained. The advantage of this technique was that, as the various layers were divided and stripped back, they carried with them most of the blood vessels of the sac and when finally the serosa alone remained there was very little left for ligation when excised. The problem of hemostasis was thus greatly simplified.

The accompanying drawings by Mr. Dikusch made at the time of operation in one of my cases (BUI 26837), patient operated upon a year ago, so graphically depict the various steps of the operation that little descriptive text is necessary. The case was one of very large hydrocele of the left side of the scrotum. As shown in Figure 1: 1 (reduced in size) the sac was grasped between the thumb and finger of the left hand and put on tension. An incision, beginning at the lower end

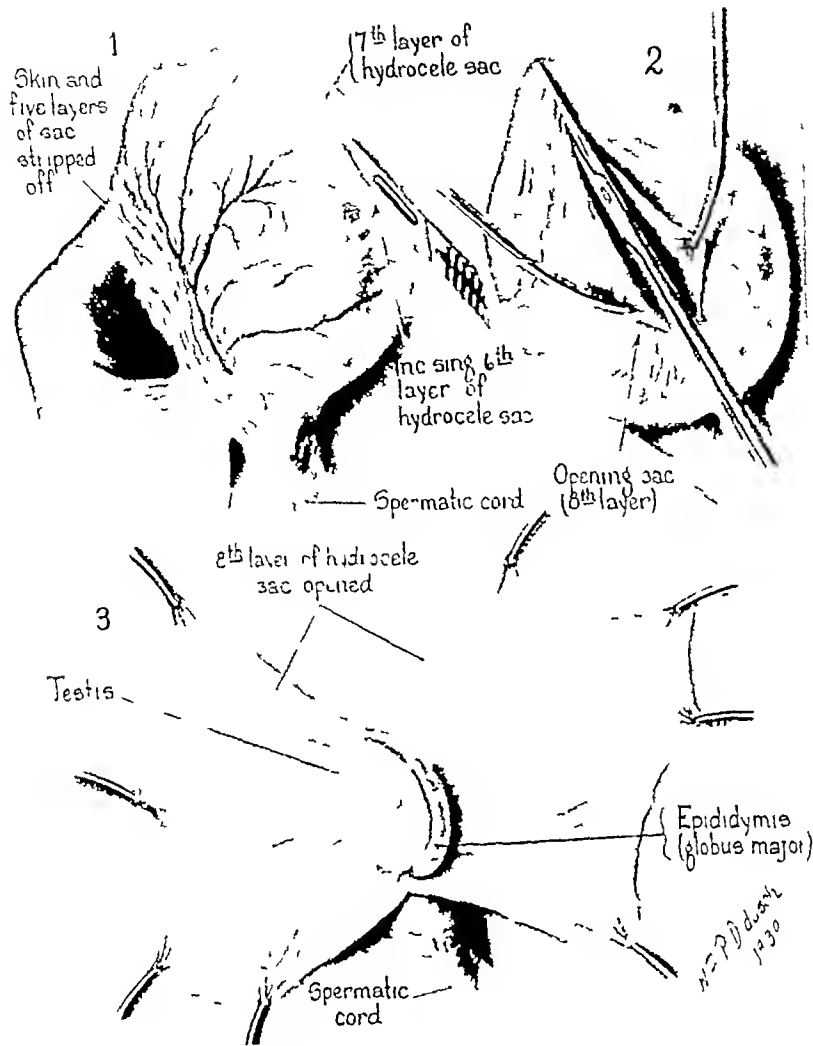


Fig 2 1 Showing condition present after five thin saccular layers have been stripped off together. This sixth layer is thicker than the other layers, contains many blood vessels, and corresponds to the subserous coat. It is easily divided, and stripped back, carrying with it the blood vessels and in some cases the vas deferens. Beneath it is a very thin layer, which may be delicately divided and stripped off from the last layer, which is the serosa or tunica vaginalis itself, 2 This is opened widely with scissors (2 and 3) (BUI 26837)

extending to the upper end, was made through the skin, thus exposing the subcutaneous fascia (Fig 1, 2) which was similarly divided (Fig 1, 2). Beneath this lay the dartos which was also divided from bottom to top (Fig 1, 2) thus exposing the outer layer of the hydrocele sac. This was delicately divided, a very thin layer being thus incised and pushed back partly on each side. Four other extremely thin layers were similarly divided. Then the five layers were

stripped back together, exposing the sixth layer, which was thick and contained numerous large blood vessels (Fig 2, 1). This sixth layer was carefully divided, thus exposing the seventh layer, which was extremely thin, transparent, but which by great care was divided with the scalpel. The sixth and seventh layers were then carefully stripped back, only the extremely thin tunica vaginalis being left intact, with the hydrocele fluid within it. This was then punctured, the

CASE 3. The sac and cords ran in the hydrocele sheath directly outside the subserous fibrous coat. There was a small fibrous band which ran from the hydrocele sac to the epididymis. This was divided. (BUI 2687)

CASE 4. After 7 layers are peeled back the tunica vaginalis was opened. Examination showed marked adhesions between the tunica vaginalis and inner half of the testicle. The testicle was dissected free, thus leaving the lower half without serosa. On the left side, although the hydrocele was small, the sac was adherent to the testicle in several places with localized areas of fluid in between. One of these passed beneath the epididymis, producing marked pressure and distortion. (BUI 2684)

CASE 5. When the incision was made to divide the subserosa, the operator unintentionally allowed the point of the knife to touch the sac, which was immediately penetrated and fluid escaped. Had care been taken to cut only with the broad side of the knife this could have been avoided. (BUI 27032)

CASE 6. A difficulty was experienced in excising the serosa from within the subserosa, which was stripped back with gauze. When the outer coats had been stripped off and the tunica vaginalis opened, it was found bound down to the tunica albuginea by very dense adhesions which required blunt and sharp dissection before the testicle could be freed. This case was characterized by considerable pain before operation. The patient had been tapped three times. (BUI 27033)

CASE 7. An assistant in describing my operation to this class says, "The various fascial layers are opened and peeled back. The hydrocele was delivered and dissection of the various thin layers of the sac carried out by blunt and partial dissection. There was very little bleeding which was easily controlled by clamps. Finally the sac was transparent, and revealed beautiful specimen ap-

parently only a few cell layers in thickness. The sac was opened, the margins trimmed as closely as the testicle replaced, and the ducts approximated with continuous plain catgut. (BUI 27035)

DISCUSSION

Non-operative treatment of hydrocele is often very unsatisfactory. Simple aspiration is followed by early recurrence of the fluid and sometimes infection.

The injection treatment often fails to cure the hydrocele and frequently results in painful adhesions.

Complete excision of the sac has encountered the objection that many blood vessels, requiring ligation, may be found, and are sometimes accompanied by postoperative extravasation. The best operation of inverting the sac, which was introduced to avoid these operative difficulties, is not infrequently unsuccessful and leaves a large mass back of the testicle and epididymis.

A new operation has been devised by the author and provides for incising the sac layer by layer and stripping the layers back until thin serous membrane is reached. This alone is excised. In this way hemostasis is easily secured, as very few vessels remain to be ligated. The operation is thus made more accurate, less destructive and hemorrhagic and is radically curative.

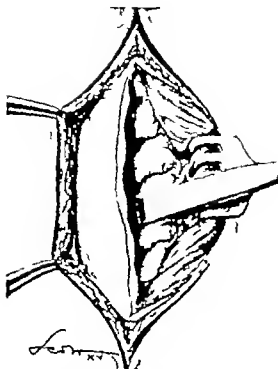


Fig. 1 Method of severing laminae with scalpel

and one can proceed according to indications, in general resection of the laminae is necessary to get to the spinal cord.

When this part of the operation is completed and the dividers have been removed, the muscular masses return toward the median line with the spinous apophyses attached to the muscles of one side and by suturing between the apophyses the whole posterior ligamentous-muscular vertebral system is reconstructed. A few superficial stitches are passed on the aponeurosis. Generally no drainage is necessary.

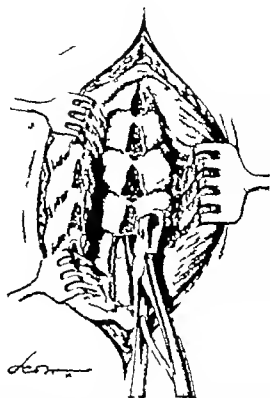


Fig. 2 A strong retractor holds apart the spinous apophyses, with the postoperative insertion of this side, and with the muscular insertions on the spinous apophyses.

I believe that this technique reduces the time of operation, that the loss of blood is diminished and, what is more important, bony protection of the spinal cord remains after the removal of the laminae. This is very important if many laminae are resected, as sometimes happens in the removal of tumors.

DOUBLE ELONGATIONS OF PARTIALLY CLEFT PALATES AND ELONGATIONS OF PALATES WITH COMPLETE CLEFTS

JAMES BARRETT BROWN, M D, F A C S, St Louis, Missouri

A METHOD of elongating partially cleft palates was described in 1936,¹ the principle of which is that practically the entire soft tissue of the palate is freed from the bone, the major palatine arteries are loosened but not cut, and the entire mass of tissue is immediately set back—as a direct flap with preservation of its arterial supply—so that the anterior part, from just behind the incisors, is anchored all the way back at the posterior border of the bone. A gain in length is thus obtained equal to about as much as the expanse of denuded bone, the object being to have the longest possible functioning palate, to assist in nasopharyngeal closure in speaking and eating.

Some of the original illustrations of the procedure in Figures 1 to 4 show the complete freeing of the tissues from the bone, the preservation of the arteries and the anchoring of the palate to a little bridge of nasal mucosa that has been left behind for this purpose. The closure of the cleft itself is done usually at the same operation—as a preliminary step—in children, but may be done as a separate operation. In adults two stages are advisable because of excessive bleeding. The sequence of the elongation and the closure does not have to follow a definite rule, therefore, a field is opened for older children and even adults, who have had clefts closed many years before, to have their palates elongated in an effort to obtain better speech.

Observations made or emphasized since the original publication may be summarized, as follows:

1 It is still thought that the direct flap, elevated and immediately set back, so that the least possible thickening will take place, is superior to the delayed flap method of elongation.

2 Preservation of the major palatine arteries (often called the posterior) is possible in nearly all patients, and freeing is effected by careful loosening of all tissue around the artery, gently stretching it from the foramen and, if necessary, carefully cutting it away from the palate flap. These methods have seemed better than trying to dis-

lodge the artery from its bony canal by trying to remove the posterior wall of the canal.

The palate may be gotten so free by this dissection plus complete separation of the aponeurosis from the bone that it may be easily "set-back," practically against the posterior pharyngeal wall in most instances. This finding is in contradistinction to that of others who think that preservation of the arteries prevents elongation.

This may seem somewhat of an equivocal point but it makes possible closure and elongation in a single stage, and it may give a less scarred and more pliable palate. If the arteries are cut, then the delayed flap method of Dorrance may be resorted to for safety's sake. However, if they have been lost at a previous operation, then the delayed advantage has already been gained and the flap could probably be used without further delay.

3 This method of elongation, even though involving a very wide dissection does not seem to interfere with the levators in the sphincteric action that attempts to close the nasopharynx. Even as the patient is waking in the operating room, very marked sphincter action can be seen.

4 In any procedure in which the posterior pillars are cut low down in the pharynx and then sutured behind the uvula to lengthen the palate, a tight scar band may be left right in the region of the greatest action, and if there is any levator action present, this procedure should be omitted if possible. The same is true of the employment of flaps from the posterior pharyngeal wall attached to the palate. These flaps may nearly or completely occlude the nasopharynx and also may give a "drum-head" noise from vibration in breathing.

5 If there has been a slough of the soft palate from previous operations, then, added to the elongation, may be the freeing and suturing of any tissue available, plus the use of a posterior pharyngeal flap attached to the palate if desired. This results in all possible closure between the mouth and nose and, as there is no levator action, amounts to a flesh obturator. This, of course, has a great advantage over a dental prosthesis or over an extra-oral flap.

6 Any type of pharyngoplasty, mainly that of Wardhill, in which there is a reefing forward of the

From the Department of Surgery, Washington University School of Medicine.

¹Surg. Gynec. & Obst. 1936 63: 768-771.



Fig. 1



Fig. 2



Fig. 3



Fig. 4

Fig. 1. Palate detached from bone but its both major palatine arteries intact. A little triangle of nasal mucosa has been left behind to which the palate is attached. It is the first suture. (All figures are diagrammatic.)

Fig. 2. Detail diagram of deep separation of the soft tissues around the artery exposure and fracture of the hamulus and complete separation of the aponeurosis from the bone.

Fig. 3. Completion of the elongation. The palate has been set back and anchored as above. Several layers of iodiform gauze soaked in balsam of Peru are placed smoothly and firmly over the exposed bone and may be removed in 5 to 7 days. The closure of the cleft may be done at this time, or subsequent step, or may have been done at an earlier operation.

Fig. 4. Completed elongation and closure after healing has occurred. It is about as much gain in length as the exposure of original bone in Figure 3.

superior constrictor may be added to this elongation procedure, but it has not proved as successful in my hands as in others.

7. Tooth buds may be damaged as in any other flap elevating operation, if done too early. Therefore the elongation can be delayed until the second year or later if desired.

8. Results of the closure and elongation have been increasingly hopeful. The bone covers over in about 30 days; the palates usually smooth out, appear good and long; and, for these reasons, the contracture on the nasal surface in healing does not seem great enough to warrant trying to skin graft the raw surface.

Speech improvement has been almost dramatic in many instances, and the use of voice recording, either by simple direct methods, or electrical transcription has been of great help in permitting the patient to hear his own defects and thereby

try to correct them. Speech training is important in all patients and the author is pleased to acknowledge invaluable help from Dr. M. A. Goldstein, Miss Mildred McGinnis, and other teachers of speech at the Central Institute for the Deaf and in the St. Louis public school system, and Dr. M. C. E. Harrison of the Technisonic Laboratories located in St. Louis for his work with electrical transcriptions.

Most patients are also able to eat better than before the elongation.

9. Failures may be expected as more difficult palates are operated upon than is, ones badly scarred and with tissue lost from previous attempts. Patients with as many as 8, 24, 45, and 55 operations to their credit in attempted repairs of lip and palate clefts have been seen.

Throughout the procedures of elongation there has been the fundamental aim that no



Fig 5



Fig 6



Fig 7

Fig 5 Diagram of a cleft with only a narrow band of bone and soft tissue, showing incision for first stage of a "double set back."

Fig 6 Healing resulting from the first stage set back and with incision for the second stage of the "double set back."

Fig 7 Completed double set back, accomplished by carefully splitting the remaining palate tissue in two from before backward and from side to side without breaking through into the nose—and literally setting the palate back on itself. The arteries usually have to be sacrificed in this double procedure. This gives a double gain in length without an opening into the nose anteriorly. The raw surface closes over in 2 to 4 weeks.

Fig 8 Completed double set-back and closure of the cleft with about as much gain in length as the distance from the palate edge to the incisors and without any opening into the nose.



Fig 8

opening should be left anteriorly, to avoid the use of an artificial dental obturator for closure of the mouth from the nose.

11 Acknowledgment is made to Dorrance for his pioneer work in calling attention to the advantage of the elongated palate and also for coining the term, "congenital insufficiency of the palate," for those instances of short palate with cleft palate speech but without an actual cleft.

12 Other methods of incision which leave a "V" of tissue over the bone, but necessitate more closure down the midline may have the immediate result of a smoother surface but give the added possibility of holes through the thin tissue that is sutured.

DOUBLE ELONGATIONS OF PARTIAL CLEFT PALATES

In some partial clefts of the palates there is only a narrow ledge of bone just inside the alveolus

with corresponding lack of mucoperiosteum with which a closure might be effected. In some of these the cleft may be so wide that even simple closure may be questionable.

Author's technique. In these patients it may be possible to do a double elongation of the palate, by first setting the available tissue back to the posterior border of the bone and then, after there is firm healing, further lengthening the palate by splitting the originally elongated part in two, from the edge of the bone backward, and from side to side. Care should be used not to open through the nasal mucosa, and the anterior free edge of the palate should be anchored entirely back on its own nasal mucosa (Figs 5 to 8).

The closure of the cleft can be done at any one of the stages or as a separate procedure. The denuded nasal mucosa and fibrous tissue heals over as readily as the denuded bone does and, on late observation of the roof of the mouth, some trouble



Fig. 9



Fig. 10



Fig. 11

Fig. 9. A complete cleft of the palate that has been closed successfully in the usual lateral flap manner showing backslap for elevating the palate.

Fig. 10. Palate freed from the bone and from the nasal mucosa by carefully splitting the palate in two from side to side and from before backward and elevating it from the nasal mucosa without breaking through into the nose. About one half the thickness of the palate is left along with the nasal mucosa.

Fig. 11. An elongation or set-back of complete cleft of the palate finished. With the anterior edge of the palate all the way back at the posterior bony edge and anchored to the nasal mucosa. No opening exists into the nose and the raw surface all over is 1 to 4 weeks. It is possible that the arteries may have to be sacrificed in carrying out this dissection, but the flap does not have to be delayed, unless there has been an accidental opening into the nose.

may be had in even discerning that the areas are healed with "scar epithelium." The steps of the procedure are most easily followed in the illustrations and their legends (Figs. 5 to 8). The arteries will have to be sacrificed at the second stage but it is apparently not necessary to revert to a delay in setting the flap back, unless a hole has been made through into the nose.

ELONGATIONS OF PALATES WITH COMPLETE CLEFTS

As a corollary to the finding that the nasal mucosa could be saved in double elongations and in palates with submucous bony clefts, it has been determined that elongations may be done in complete clefts of the palate that have been successfully closed at a preliminary operation. This elongation is also done to avoid an anterior opening into the nose and, therefore, to avoid the need of an artificial dental obturator.

Another technique. The elongation is carried out as described for the partial clefts except that extreme care is taken to split the tissue in two from side to side and from before backward, leaving about one half the thickness of the palate and, of course the nasal mucosa behind. If even a small opening were made through into the nose, it would be best to replace the flap and elevate it later with another attempt at not opening into the nose. The arteries may have to be sacrificed and, if there is any question of the blood supply, a delay in setting the palate back should be made. However, it is usually possible to go ahead with the elongation in a single stage (Figs. 9 to 11).

More difficulties in general can be expected in this procedure, and observations are limited for the present, but it makes possible a definite hope for improvement in speech in many patients who have had complete clefts simply closed many years before.

BONE GRAFTING

A New Technique

JOHN B CHESTER, M D, F A C S, Fort Sam Houston, Texas

ABOUT two and one-half years ago, after considerable experience in the use of the various mechanical apparatus devised as aids in the reduction and maintenance of reduction of fractures of the long bones, it occurred to the writer that certain of these gadgets might be of considerable help to the surgeon in certain bone grafting operations, particularly in the case of the long bones of the forearm and leg. The functions of the apparatus in bone grafting are to act as an almost perfect technical assistant to the operator in holding the limb while the site of non-union is exposed, to aid in manipulation of the fragments including their separation for freshening and shaping of the bone ends, to hold the properly fitted bone ends in approximation, and to assist in the complete immobilization of the fragments during the period of healing. The technique used by the writer is, in the beginning, almost identical to that used in the reduction of fractures. Kirschner wires, usually sixteen gauge, are passed through the upper and lower ends of the long bone, as illustrated in Figure 1a. In fractures near the lower end of the tibia, it is

Medical Corps, U S Army

usually preferable to insert the lower wire through the os calcis rather than the lower end of the tibia (Figs 3a and b). In choosing the apparatus to be used, the writer has found that any of the various long bone reduction apparatus in which the traction bows for suspending the limb will also grasp and tauten the wires are satisfactory. Such an apparatus is illustrated in Figure 1b. In one of the best and most widely used fracture reducing apparatus the traction bows are not made to grip the Kirschner wires. Separate wire tautners are furnished with this machine, which, unfortunately, must usually be placed over the limb and in the operator's way. Such a machine is illustrated in Figures 2a and b. With this machine the technique described here could be used, should heavy pins not requiring tautening be used instead of Kirschner wires. However, we feel that there is very little excuse for using a heavy traumatizing pin in any case in which a small caliber Kirschner wire will function as well.

The technique described here is that routinely used in tibial grafts, as it is in cases of non-union of this bone that we have found the use of the apparatus described most valuable. It is our



Fig 1 a, left, Insertion of Kirschner wire drills through upper and lower end of tibia (Illustration is from routine fracture case) b, A type of apparatus ideal for use in bone grafting (Illustration from routine fracture case) A, Upper wire, B, extra wire through upper fragment for better fixation in cast, C, lower wire, more often inserted through os calcis, especially with fractures of lower third



Fig. 2a



Fig. 2b

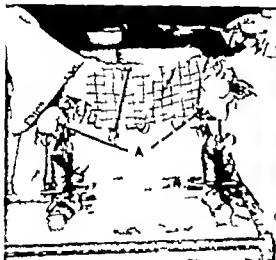


Fig. 3a

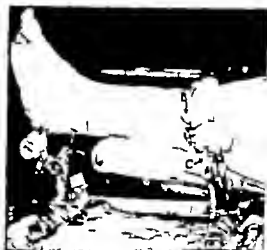


Fig. 3b

Fig. 2a and b. An apparatus extremely popular for reduction of fractures, but not adapted to the technique described herein. *A*, Separate air-tightners required with this apparatus could be in the operator's way. *B*, The box does not grasp and tighten wires as do those of apparatus in Figure 3.

Fig. 3. *a*, Leg suspended in apparatus and partially draped. Site of non-union has been exposed. *b*, Ends of Kirschner wires covered to prevent nicking of gloves or hands. *c*, Cast applied after completion of operation. Tension holders, *B*, have been applied to upper wires prior to removal of traction box. *C*, not yet applied to lower wire. Limb removed from frame when plaster is hard enough, usually in 20 to 30 minutes.

Fig. 4. Case W. A. H., aged 30 years. *a*, Roentgenogram shortly after injury through ladder in cast, compound fracture with loss of inches of tibial bone substance and extensive destruction of soft tissue and circulatory damage. *b* and *c*, Lateral and anteroposterior views after 1 year showing non-union of tibia with

inches of shortening. Weight bearing as possible the past 6 months in caliper splint.

Fig. 5. Case *a* and *b*, Lateral and anteroposterior views an cast after repair by shifting tibia graft. Note the Kirschner wires, through the upper and through the lower end of the tibia to allow the use of the fracture reducing apparatus during operation and to immobilize the limb in cast. The upper end of the graft, *A*, is fixed in the bed by Kirschner wire the point of which, *B*, penetrates the skin to allow easy removal later. The distal end of the graft is beveled and fitted in undrained graft bed and requires no other fixation. Cast unfortunately obscures detail.

Fig. 6. Case *a*, Leg in cast following operation. Note the bone made wire tauteners applied to the upper and lower wires before the removal of the leg from the apparatus. Small aluminum commercial tension holders (Fig. 7) are much easier and do not obstruct the ray *A* window cut in the cast for the removal of the skin sutures. Immobilization of knee is not essential when the upper fragment is fixed by two wires.

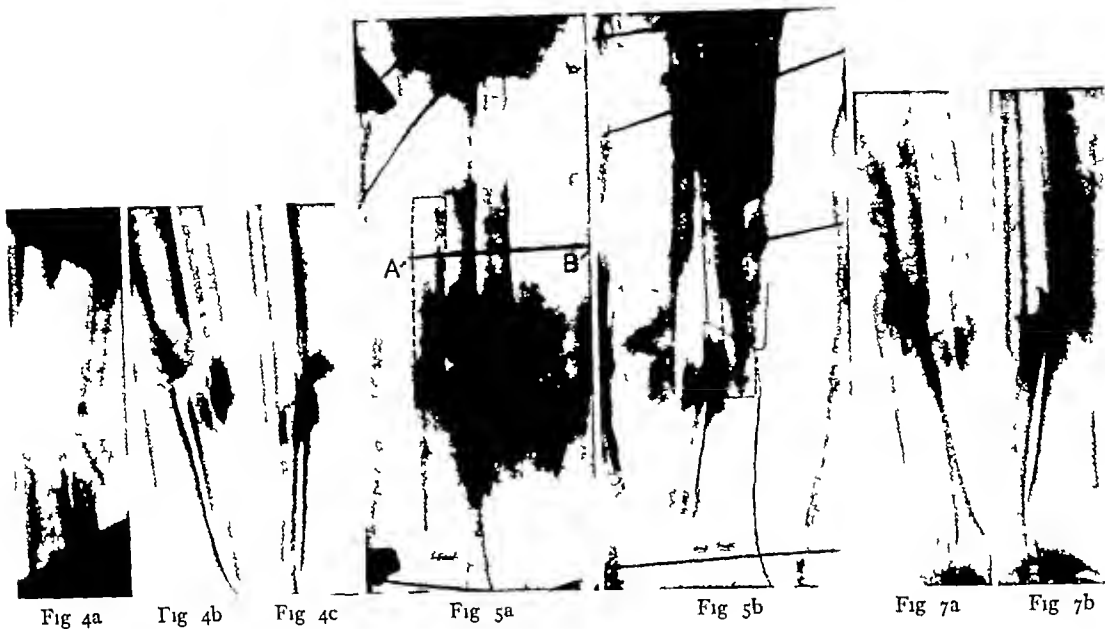


Fig 4a

Fig 4b

Fig 4c

Fig 5a

Fig 5b

Fig 7a

Fig 7b

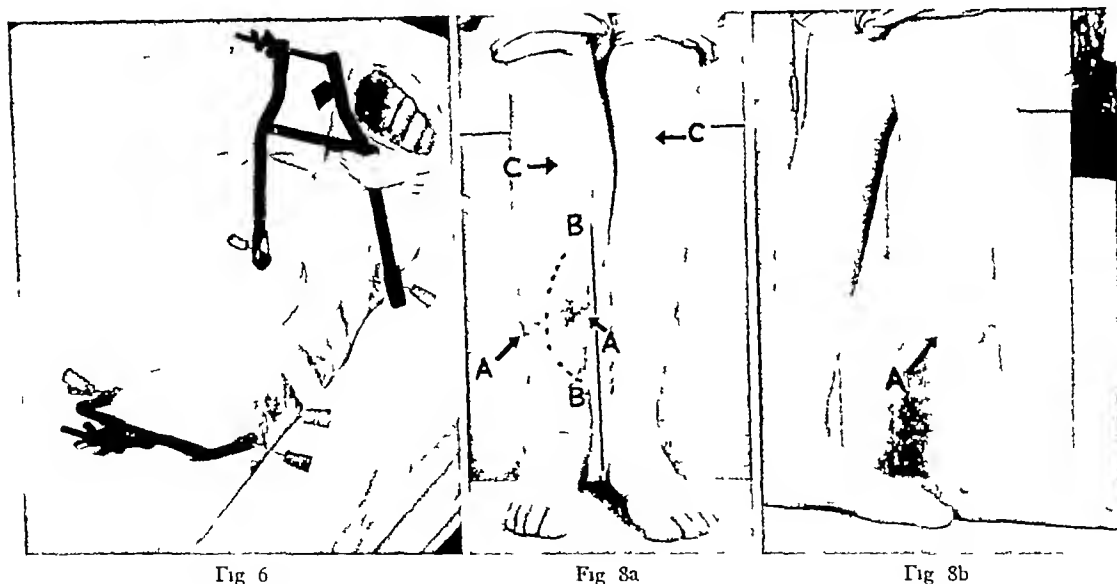


Fig 6

Fig 8a

Fig 8b

Fig 7 Case 1 a and b Lateral and anteroposterior views 3 months after operation. The graft is still clearly visible. Note the direct firm, bony union between the fragments almost without callus, the result of the close approximation and accurate fitting of the fragments made possible with apparatus described by reversing its function of traction to obtain actual impaction. Fibula was not disturbed at operation as union was already firm.

Fig 8 Case 1 a and b Photographs on day of removal of leg from cast. A, Note extent of original soft tissue damage almost resulting in traumatic amputation. B, Operative incision followed dotted line. C, Shortening due to loss of bone substance compensated by lengthening heel and by slight pelvic tilt. This soldier has been able to perform full military duty without discomfort during the past year.

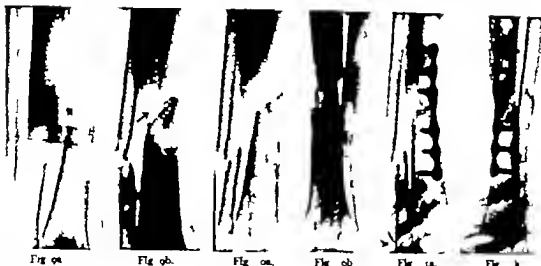


Fig. 3. Case 2. L. P. W., aged 9 years. a, Roentgenogram showing fracture at junction of lower and middle thirds of right tibia and fibula. b, Anteroposterior view in cast 3 months after poor reduction, showing on extension of tibia, arrow which undoubtedly caused failure of union.

Fig. 3. Case 2. a and b, Anteroposterior and lateral views after removal of cast, 4 1/2 months after injury. The tibia shows no union, the fibula, partial union.

Fig. 3. Case 2. c and d, Fracture plated 8 months after injury.



Fig. 4. Case 3. G. L. G., aged 41 years. a, left, and b, Anteroposterior and lateral views of old gunshot wound of distal third of shaft of radius, left. Fibrous of 3 inches of bone substance and extensive soft tissue destruction. Injury sustained year previously. Patient had had 3 operations, including one unsuccessful bone graft during past year (at various other hospitals). Note scattered lead fragments.

custom to prepare the limb 24 hours previously by shaving, washing with ether iodine and alcohol and covering with sterile gauze followed by sterile stockinette sewed at one end and rolled before sterilization. Any of the various recognized surgical antiseptics may of course be substituted for iodine. On the operating table the leg is again prepared by skin antiseptics, after which the Kirschner wires are passed, two through the upper end of the tibia, and one through the lower end or on calcus as desired. The leg is then suspended in the previously sterilized fracture reducing apparatus by fixation of one of the upper wires and the lower wire in the tension bows provided for that purpose. The leg is now draped and the site of non-union exposed (see Fig. 3a). The technique for the upper extremity is similar only different arrangement of the apparatus being required (Figs. 1a, 2a, b, and c). A moderate amount of extension is applied to the site of non-union by means of the apparatus and after such fibrous union as may exist is cut through, this extension is increased until the bone ends are separated from one-quarter to one-half inch. The ends may now be thoroughly freshened and properly shaped and then by reversing the machine may be fitted together and impacted. In this manner they are held quite firmly without the aid of manual assistance while a sliding graft is cut or an onlay graft bed is prepared. With this technique the writer most often uses a sliding in-

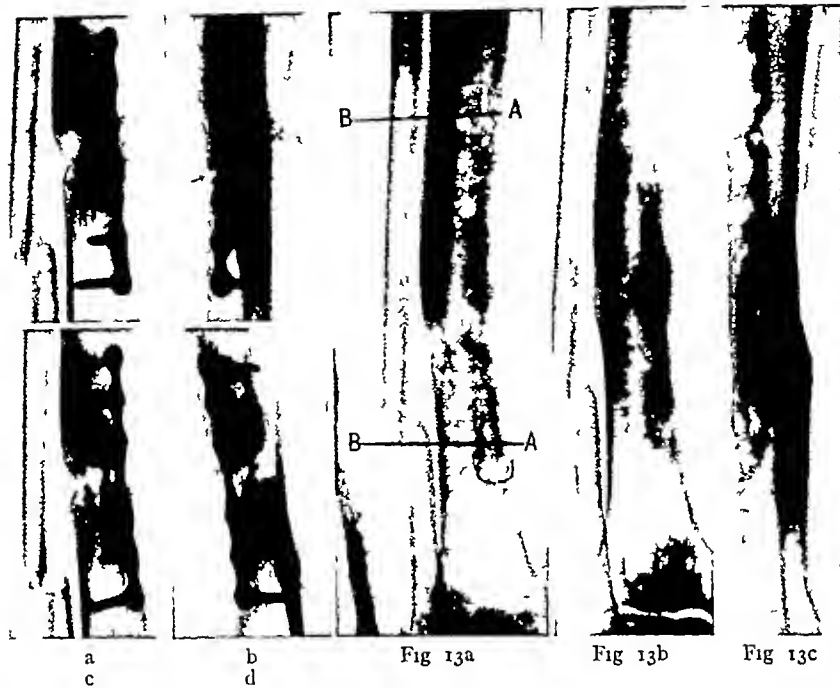


Fig 12

Fig 12 Case 2 a and b, Anteroposterior and lateral views 3 months later, showing no union of tibia, firm union of fibula. Arrow indicates fracture line which is clearly visible. c and d, Three months later and 14 months after injury. Patient had been walking with caliper splint for 3 months. No bony union of tibial fracture is present. Erosion has taken place at fracture site. Note the erosion and absorption of bone about the plate and screws.

Fig 13 Case 2 a, Anteroposterior view 6 weeks after removal of plate and insertion of inlay bone graft. Union has started. Note both ends of graft fixed by Kirschner wires, A, the points perforating skin laterally, B. Usually the distal end of the graft is beveled and fitted in the undermined lower end of the bed and does not require fixation. Note screw holes of old plate. Upper and lower extremities of graft indicated by dotted lines. b and c, Anteroposterior and lateral views 6 months later, showing firm union. Patient has been performing full military duty for 3 months.

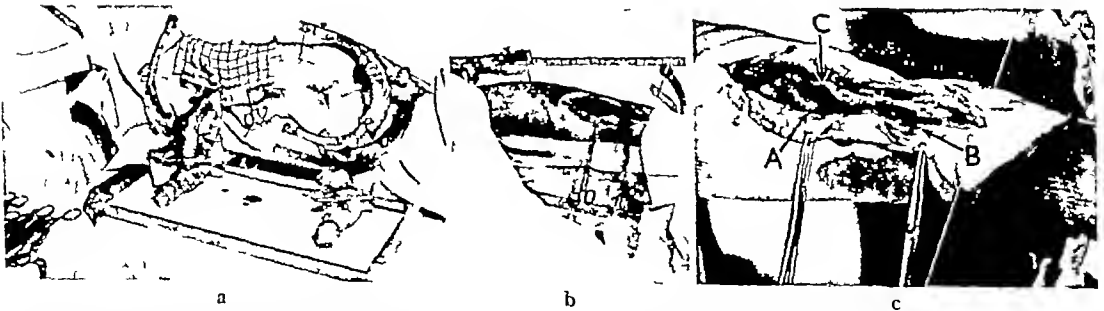


Fig 15 Case 3 a, Left forearm in apparatus, area for bone grafting exposed. b, View of opposite side. (Skin towels removed). c, Enlargement of operative wound showing defect in radius to be grafted. A, End of proximal radial

fragment, B, end of distal fragment, C, ulna intact. Note irregularity of skin caused by dense depressed scarring from loss of soft tissue and skin in original injury and three previous operations.



Fig. 10. Case 3. A. Anteroposterior view following bone graft. One inch graft, *A*, placed between fragments. A 4 inch tibial graft, *B*, as imbedded in the radial head and fitted to the lateral surface of the upper radial fragment. A long graft, as fixed by two Kirschner wires, either end, the proximal ends of which are brought out to the side of the forearm to prevent interference with primary healing. Note the lengthening of the radius accomplished by skeletal traction in the fracture reducing apparatus. Full lengthening was not possible because of the extensive fibrous and scar contraction. Cellular bone, *C*, on the outer surface of graft. Each is placed tightly against the shaft of the radius casts little shadow and thus gives the erroneous impression of space between the cortex of graft, *B*, and shaft of radius. Lateral view after removal of traction bow, *D*, and substitution of aluminum tension holders, *E*. Short tibial graft, *F* and *G*. Upper and lower ends of long tibial graft.

lay graft which is easily and accurately cut with a parallel saw while the bone ends are firmly held together by the apparatus. In the use of the sliding graft it is our custom, in fractures in the lower half of the limb to undermine the lower portion of the graft bed and to bevel the upper portion of the graft to fit this undermined area. In other words, the graft is reversed and the short portion of the graft taken from the lower fragment is replaced to fill the defect in the upper bed. This procedure leaves the lower end of the graft fixed, but the upper end is free in the graft bed and requires mechanical fixation. We have found that a convenient method of fixing this upper end



Fig. 11. Case 3. Forearm and arm in cast following operation. Traction bow has been removed. Tension on the Kirschner wires is maintained by aluminum tensioners. This case is too recent to show final results but it is presented to illustrate the technique as described.

of the graft is to transfer the cortex of the graft obliquely with a Kirschner wire which penetrates the cortex of the parent bone and is carried, usually laterally, out through the skin. The Kirschner wire is then cut flush with the graft (Fig. 5, 1, *B*). This results in a much more firm fixation than can be obtained by any other practical method. When the x-ray film shows that the graft has become fixed in its host and a large portion of the parent bone, the Kirschner wire can be grasped by the point protruding through the skin and easily removed without disturbance of the operative site. Usually this Kirschner wire can be removed by the end of month and the patient has known of no case in which delayed union of the graft or irritation of the bone was caused by its presence. In fact the firm fixation of the graft which it affords is undoubtedly a contributing factor in the early bony fixation of the graft.

A distinct advantage in the use of such an apparatus as described and the retention of the multiple Kirschner wires for incorporation in the plaster is that the fragments are held firmly together in the cast almost without movement, which is extremely important to high percentage of success in bone grafting (Figs. 3b and 6). Without the wires imbedded in the cast, tissue atrophy and shrinkage always leave the limb loose in the cast after few weeks. This same tissue atrophy is our reason for inserting two Kirschner wires

rather than one through the upper end of the bone. We discovered some years ago by rather bitter experience that if one wire or pin is used in the proximal end of the tibia in cases of fracture, this same tissue atrophy would leave the weight of the upper portion of the limb suspended on this one wire or pin. This resulted in such leverage that rotation of the upper bony fragment would frequently take place at this wire, which merely acted as an axle, tending to displace the proximal fragment anteriorly at the site of fracture. When two wires are used, the proximal bony fragment is held in two planes making rotation, and therefore displacement, relatively impossible. We have found routinely that when this method of grafting is used, firm bony union has regularly occurred earlier and with considerably less callus formation than if wires were not used, with relatively much less snug apposition and rigid fixation of the fragments.

CONCLUSIONS

1. A technique is presented to simplify the operation of bone grafting by mechanically separating the bone fragments for freshening and shaping, holding them tightly approximated while

the bone graft is cut and fixed, and finally, fixing the fragments immovably in the cast until union is completed. Three illustrative cases appended.

2. A method is suggested for fixation of the free upper end of a sliding bone graft in its bed by transfixion of the graft and cortex of the tibia with a Kirschner wire which may later be removed without disturbance of the wound or the fragment or open operation. In the case of onlay grafts this technique is modified by the passage of a Kirschner wire obliquely and in opposite directions at each end of the graft, the proximal ends of the wire being brought out through the skin to the side of the incision instead of penetrating the limb until the distal end of the wire perforates the skin, as in the case of the sliding graft. The reason for this difference is that in the case of the sliding graft, the wires are passed almost horizontally through the cortex of graft and parent bone without danger of damage to deep vessels, whereas with the onlay graft the wires are passed obliquely posteriorly and should they be allowed to penetrate the soft tissues, might accidentally strike some of the deep vessels with more or less serious consequences.

Photography by U S Army Signal Corps, Fort Sam Houston, Texas

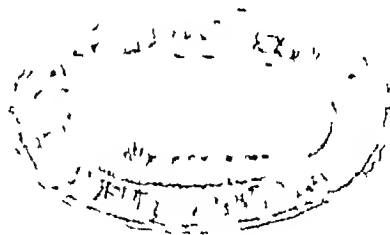




Fig. 6. Case 3. a. Interposterior view following bone graft. One inch graft, *A*, placed between fragments. A 6 inch tibial graft, *B*, as imbedded in the radial head and fitted to the lateral surface of the upper radial fragment. A long graft, as fixed by two Kirschner wires at either end, the proximal ends of which are brought out to the side of the incision to prevent interference with primary healing. Not the lengthening of the radius accomplished by skeletal traction in the fracture reducing apparatus. Full lengthening is not possible because of the extensive fibrosis and scar contraction. Cellular sponge, *C*, on the under surface of graft which is placed tightly against the shaft of the radius casts little shadow and thus gives the erroneous impression of space between the cortex of graft, *B*, and shaft of radius. b. Lateral view after removal of traction box. *D*, and substitution of aluminum tension holders. *E*, Short tibial graft. *F* and *G*, Upper and lower ends of long tibial graft.

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Fig. 7. Case 3. Forearm and arm in cast following operation. Traction box has been removed. Tension on the Kirschner wires is maintained by aluminum tensioners. This case is too recent to show final results but it is presented to illustrate the technique has described.

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Photography by U. S. Army Signal Corps, Fort Sam Houston, Texas

NON SURGICAL CLOSURE OF VESICOVAGINAL FISTULA

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THE treatment of vesicovaginal fistula is quite generally considered a problem of gynecological or general surgery. However, Kelly, a pioneer gynecologist and cystoscopist, has always stressed the advisability of careful cystoscopic investigation and the routine catheterization of the ureter for protection during the operative repair.

Many operations for the closure of vesicovaginal fistulas are conducted without careful urological study, and certain types of fistulas, which might be closed by more simple urological treatment, are frequently subjected to extensive surgical procedures. Multiple operations often reduce the size of the fistula without affecting the necessary closure that restores normal bladder function. It is generally recognized that the frequency of healing decreases after each operation for repair of these fistulas.

The purpose of this report is to emphasize the possibility of success in closing less extensive defects by cystoscopic and vaginal coagulation of the tract and proper prolonged postural drainage of the bladder by means of an indwelling urethral catheter. This procedure has received little or no consideration in the voluminous literature on the subject of vesicovaginal fistula. One finds no mention of it in standard texts on gynecology. Zabrowski, in a recent article, states that the most important conservative method of treating the fistula is permanent catheterization. Of 45 cases collected from the literature in which this procedure alone was employed, healing resulted in 6. Ottow has advocated electrocoagulation for small vesicovaginal fistulas and recommends that an indwelling catheter be left in the bladder for 30 days. Quimby has reported the final healing of vesicovaginal fistula after cystoscopic electrocoagulation when closure of the defect by surgical repair had not been complete.

The following personal experiences are given in the hope of stimulating more interest in this subject among both urologists and surgeons in general.

CASE 1. In August, 1927, a woman, aged 24 years, who had been suffering from vesicovaginal fistula for years, was examined. The fistula resulted from incision of the bladder during a vaginal stemplasty operation. The latter

had been done some weeks after an induced abortion, necessitated by an extreme thyrotoxicosis. Prior to this examination, numerous attempts had been made at fistula closure by the gynecologist treating her. On each occasion the patient had had very stormy times and had barely come through the immediate postoperative period. Although the incontinence of urine as complete cystoscopy showed the fistulous opening to be only about 3 centimeters in diameter and located about 5 centimeters above and just medial to the left ureteral orifice. Coagulation of the fistula both from the bladder and vaginal sides was suggested. With the idea that the fistula might close spontaneously. This was done. A light current was used just enough delectation to destroy the epithelial tract thoroughly. The patient returned home and showed no improvement for a month, after which time she began to void from 3 to 4 ounces at a time but continued to drain partially through the vagina.

Encouraged by this partial closure, it was believed that if the area of the fistula could be kept relatively dry during the sloughing and healing stage, complete closure might be effected. A bed as prepared in the hospital by cutting a hole in the mattress so that the patient could lie on the abdomen and an indwelling catheter stuck directly into a bottle beneath the bed. The fistula, as upon delectation both fore and aft and an indwelling catheter as inserted. The patient maintained position on her abdomen for 3 weeks, without vaginal leakage. Removal of the catheter showed complete closure of the fistula and bladder function had quickly returned to normal. This patient has remained well. In July 1928, she had a thyroidectomy performed and is now reported to be in splendid health.

CASE 2. A similar case in which this treatment seemed suitable did not present itself until September, 1928. A woman, aged 48, applied for admission. She had had vaginal hysterectomy in February 1926, the resultant vesicovaginal fistula, apparently from the sloughing around a deeply placed chronic catgut suture. One attempt at vaginal closure had been unsuccessful in the hands of skilled gynecologist. As is well known, vaginal closure in patients previously hysterectomized per vaginam is frequently very difficult. On cystoscopy this patient was found to have fistulous opening just to the right of the urethra, some 1 1/2 above the base found and 3 centimeters superior to the right ureteral orifice. The fistulous tract admitted No. 8 bougie easily. Coagulation of the area and the tract by inserting the electrode directly into the fistula with fine delectation current, insertion of No. 24 F. catheter introducing urethral catheter and maintaining the patient in a completely upright sitting posture on specially prepared backrest for 4 weeks resulted in complete and permanent closure of the fistula.

CASE 3. In February 1930, a woman, aged 45, who had had supra vaginal hysterectomy in October 1914, was examined. In this instance deeply placed chronic suture had apparently sloughed through the bladder wall and caused vesicovaginal fistula.

In March, 1931, an unsuccessful attempt to close the fistula by vaginal surgery was accompanied by severe hemorrhage and prolonged hospital convalescence of 3 months. The surgeon in this case, as man of undoubted ability, had later advised that patient that he could close the fistula

by a combined suprapubic and vaginal operation. Because of the difficult convalescence she had had, this patient was loath to enter upon another surgical experience. On cystoscopic examination the fistulous opening admitted a No 14 F bougie snugly. The opening was located 0.5 centimeter above and just medial to the left ureteral orifice. A darkened area embedded in the tissue superior to the opening suggested the presence of a piece of chromic catgut. Desiccation both vesically and vaginally was performed in the office and a No 22 F mushroom catheter fixed in the urethra. A backrest was purchased and placed on her bed at home, the catheter drained into a bottle at the bedside.

The patient stayed in the upright sitting posture for 4 weeks. She was allowed to stand at the bedside several times each day at which time the catheter was disconnected by the nurse. On removal of the catheter cystoscopic examination showed complete closure of the fistula. This patient has normal bladder function and has been able to resume all her activities, including golf and horseback riding.

CASE 4 In July, 1936, a woman, aged 45 years, presented herself with a condition almost identical with that of the preceding patient. In 1933, a diagnosis of early carcinoma of the cervix uteri was followed by vaginal application of radium. Six months later a total supravaginal hysterectomy was done and the patient developed a vesicovaginal fistula. The gynecologist who operated states that this is the only instance in 2,800 hysterectomies. In July, 1935, the same gynecologist, assisted by a competent urologist, was unsuccessful in closing the fistula by a combined suprapubic, intravesical, and vaginal repair.

Sections of the uterus removed in 1935 had failed to show evidence of carcinoma in the cervix or body of the uterus. In July, 1936, incontinence had been complete since the previous operation. The fistula was situated just above the interureteric ridge 1.0 centimeter medial to the right ureteral orifice. A No 14 F bougie seemed to fill about two-thirds of the lumen of the fistula. There was no evidence of infiltration suggestive of malignancy in this region. The fistulous tract was completely coagulated through the cystoscope, the vaginal exposure was unsatisfactory. A No 24 F mushroom catheter was inserted in the urethra, and the tubing was attached to a mild suction bottle at the bedside.

The patient maintained an upright sitting posture with slight pillow elevation of the hips for 28 days. On removal of the catheter the patient voided from 150 to 300 cubic centimeters of urine at a time but there was slight dribbling when she was up and about. There was no incontinence when lying in bed. The dribbling ceased in 10 days. Apparently it was urethral in origin and was the result of the prolonged presence of so large an indwelling catheter. Cystoscopy 6 weeks later showed complete healing of the bladder and normal function has continued.

Successful closure in these 4 instances was accomplished by (1) destruction of the epithelial tract and subsequent freshening of the edges, (2) indwelling catheter drainage with postural attempt to keep fistulous area as dry as possible, and (3) continuous acidulation of the urine to prevent lime encrustation of the coagulated tissue. In the last 2 patients described, this was accomplished by an acid-ash diet and doses of ammonium nitrate large enough to maintain a hydrogen-ion concentration of 5.5 or lower.

Two instances of the relation of syphilis to the healing of vesicovaginal fistula are worthy of record.

CASE 5 In January, 1928, a 24 year old society matron stated that in August, 1926, she had been delivered of her first child by forceps and had developed a vesicovaginal fistula. She had been in excellent obstetric hands and the incident had caused considerable embarrassment. In June, 1927, she was operated upon. The fistula was closed for 3 weeks but re-opened with complete incontinence. Examination in January, 1928, showed a very small fistulous opening in the bas fund midway between the ureteral orifices. Traction on the cervix brought the vaginal opening of the fistula into excellent view. It was difficult to understand why a closure had not been effected. The patient was assured that a perfect repair from the vaginal side could be done.

The operation was so easy and so satisfactory that no attempt was made to keep the area dry by posture, although an indwelling catheter was retained for 3 weeks. The patient voided normally without leakage for 48 hours, after which time partial urinary leakage recurred from the vaginal tract. The results were puzzling and discouraging until an enlarged epitrochlear node was noted and treated. This node had been overlooked but had been recorded on her chart by the interne. The blood Wassermann, previously omitted from the routine, was returned as 4 plus. Reinsertion of an indwelling catheter and intravenous arsphenamine resulted in a complete closure of the tract in 14 days. Subsequent antiluetic treatment and observation until July, 1931, showed no recurrence and serological cure.

CASE 6 In March, 1928, with the previous experience freshly in mind, we were consulted by a Mexican girl, 19 years of age. She was completely incontinent from a small vesicovaginal fistula following her second delivery 4 months previously. The blood Wassermann was 4 plus. The fistula admitted a No 8 F bougie and was 0.5 centimeter above and medial to the right ureteral orifice. Intravenous arsphenamine, without indwelling catheter or other local measures, resulted in complete closure of the fistula after 14 days. The patient was observed for another 2 weeks, during which time her bladder functioned normally. She then disappeared and has not been seen since.

CONCLUSIONS

Small vesicovaginal fistulas with healthy surrounding tissue will heal after electrocoagulation, if postural drainage can be maintained with an indwelling catheter for a sufficient period of time. The possibility of this method should receive more consideration, especially in patients upon whom an unsuccessful surgical repair has resulted in a small lateral opening. The method obviously has no place in the treatment of fistulas of the bladder floor or in patients with extensive tissue defects.

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THE VENOUS CIRCULATION IN THE VARICOSE EXTREMITY AND ITS PRACTICAL SIGNIFICANCE

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THE subject of varicose veins has acquired an enormous literature much of which however is a repetition of facts or supposed facts which have followed the original observations of Trendelenburg and Brodie who first pointed out the reversal of blood flow in varicose veins during the assumption of the erect position. A perusal of the present day textbooks and articles on the subject, demonstrates several conceptions which appear to be based more on supposition than on actual fact. These suppositions have been passed down from textbook to textbook and from teacher to student, to the point where they are now accepted as undisputed fact. Because numerous operative procedures have been based on these ideas, some of which are unduly extensive I would like to examine and discuss the present day clinical information on the subject.

First In the presence of incompetent valves in the great saphenous vein there is a reversal of the normal blood flow from above downward in the erect or semi-erect position. This is demonstrated clinically by the Trendelenburg single test, which consists of pushing a tourniquet lightly about the upper thigh sufficient to constrict the superficial veins only. This is applied with the patient recumbent and the superficial veins emptied by elevation. Then when patient stands and the tourniquet is released the veins fill rapidly from above downward.

This fact is the basis for an understanding of the venous circulation in varicose veins and must always be kept in mind when treatment is instituted. This condition is well shown in Figures 4 and 5 where the radio-opaque solution was injected at the level of the knee with the patient standing and only those veins distal to the injection were visualized.

Bearing this reversal of flow in mind, one can readily see why the injection treatment in such cases gives constant results. Frequently the solution fails to take or when thrombosis does occur recurrences almost invariably appear in the succeeding 5 years. Kettel has reported the follow-up of a series of 5 cases in which patients were treated by injections alone. He reports a

recurrence rate of 86.6 per cent over a 5 year period. Other authors have reported similar figures. These recurrences are due chiefly to the dilatation of small collaterals produced by the constant pressure exerted by the reverse flow from above. When a segment of the main vein is blocked the collaterals above the thrombosed area must enlarge to lead off this reverse flow. Occasionally recanalization is a factor in recurrence. The patient states that she felt relieved for a year or more and then a new set of enlarged veins gradually appeared. Obviously then the source of this reverse flow must be closed off as the first step in the treatment. This is accomplished by a ligation of the great saphenous vein at the saphenofemoral junction.

This reversal of flow is usually the first feature of importance in cases with enlarged veins, and it initiates a long series of progressively serious difficulties and complications.

Second. It is believed that in greater degrees of incompetence and valve incompetence the veins communicating between the superficial and deep systems also develop valvular insufficiency and blood regurgitates from the deep to the superficial veins. This is supposedly demonstrated by the Trendelenburg double test in which the lower superficial varices fill rapidly (0.1-20 seconds) after patient assumes the erect position and the tourniquet still remains on the thigh. It is argued from this that these varices fill too rapidly for the normal returning venous circulation and because the reflux has been shut off from above then these varices fill by blood coming from the deep circulation through incompetent communicating veins. This idea has been extended to the point where masses of dilated superficial veins localized in one area are called a "blow out" point for it is claimed that that is the situation of junction of a large incompetent communicating vein with the superficial circulation.

Anatomically the great majority of the communicating veins are present in the lower leg although Ochsner and Mahorner (9) have found by their comparative tourniquet test that the veins mainly involved are present in the lower thigh. Theoretically one would believe that if

From the Varicose Vein Clinic of the Royal Victoria Hospital

incompetent communicating veins were to be found, they would more likely be in the lower leg, both on anatomical and physiological grounds. On the contrary, all the venograms done in the present series showed normal communicating veins in the lower leg, as it was through these that the reversed superficial flow was so rapidly dispersed into the deep circulation. This was true even in the most marked cases of varicose veins showing Trendelenburg "double" test.

While I do not claim that there is no such thing as an incompetent communicating vein, I believe that they are very rarely present and are not of sufficient importance to warrant the extensive operations designed for their removal.

The dissections carried out by Linton are excellent in their demonstration of the communicating veins, but there is no proof that reverse flow does occur through them, consequently the extensive operative procedure which he advocates for their ligation seems unnecessarily severe, and I believe that his results would have been equally good by stopping at the procedure of high ligation and retrograde injection of the great and small saphenous veins.

The presence of incompetent communicating veins is only a supposition based on the interpretation of various clinical tests. It is difficult to prove that they actually exist. The fact that a branch vein penetrating the deep fascia is seen to bleed when cut is no certainty that the blood is coming from the main deep veins, because these communicating veins receive many small collaterals before the valves between the deep fascia and the deep veins are reached.

The phenomenon revealed by the Trendelenburg "double" test can be more plausibly explained by incompetence of the small saphenous vein. The widespread anastomoses between the two veins is well known. Clinically this point can be proved by applying the tourniquet just below the knee after the veins have been emptied by leg elevation. Then on patient's standing, it is seen that the great saphenous vein fills immediately down to the level of the tourniquet, but the varices of the lower leg, which had previously shown rapid filling with the tourniquet around the thigh, now remain collapsed, filling slowly after half a minute or more.

Figures 6 and 7 show that the opaque medium injected into the superficial veins rapidly leaves them and is dispersed by the deep circulation. Normally acting communicating veins are the means of the dispersal.

The clinical applications of the above statement are obvious, namely, that, in the treatment

of vein cases showing the Trendelenburg "double" test, both the great and small saphenous veins should be interrupted where they join the deep circulation. I have made this a routine procedure in the past 58 cases showing the "double" test, in which ligation and distal injection with sodium morrhuate solution have been carried out. Twenty-two of these cases had the complication of varicose ulcer. In all of these cases except 6, there has been definite evidence of incompetence of the small saphenous vein. My criteria for stating that incompetence is present are the following: a marked increase in size of the vein lumen, thickening of the vein walls and the fact that a quantity (2 to 4 c cm) of the sclerosing solution can be injected retrogradely without any difficulty. When one attempts to inject fluid retrogradely in a vein with competent valves very little can be put in before the vein wall near the cannula begins to distend and the injection is halted. The inclusion in this series of the 6 cases in which these criteria were not present (chiefly the first and third) was probably due to an incorrect interpretation of the original test.

Third. We are instructed by all our textbooks now to interfere with varicose veins when a history of deep phlebitis is present, because these veins are supposed to be a compensatory phenomenon for the blocked deep veins. I believe this conception to be incorrect, because in the majority of cases in which a deep phlebitis has been present, no incompetence of the superficial veins subsequently develops. The leg and foot show edema, malnutrition, eczema, and ulceration, but seldom varicose veins. In those cases in which the two co exist, the varicose veins probably were present before the onset of the deep phlebitis and may have been a factor in its onset. In such cases when the superficial veins show incompetence of the great or great and small saphenous veins, this fact is a test in itself to show that the deep veins are competent to carry the load of the venous return of the leg, because the reverse flow in the superficial veins in the erect position must be returned by the deep circulation. These superficial veins then are just an added burden on the deep circulation which is taxed to its utmost, and benefit will result from their removal.

That this is the case has been demonstrated by 2 such patients, in one of whom great and small saphenous ligation, and in the other great saphenous ligation were carried out. Four cubic centimeters of sodium morrhuate solution was used in each case and no evidence of further deep vein thrombosis resulted. In both cases there was a marked reduction in the chronic swelling of the



Fig. 1 Section 1 the ankle is normal individual, legs standing. The veins show normal caliber straight, all, and no tortuosity. The injected material mounts upward even though subject is standing.

Fig. 2 Roentgenogram showing marked tortuosity, variculation, and incompetence of the veins of the lower leg. A pericarditis from an overlong ulcer is also present.

Figs. 3 and 4 A marked degree of incompetence with the associated tortuosity and accumulation of the veins of the lower extremity. The dilated associated collaterals are well shown. The leg is almost clear of the injected fluid 30 seconds after the first picture.

leg and this has been maintained. An ulcer present for 6 years in one of the cases slowly healed and a marked eczema present in the other case was rapidly relieved.

Fourth. Blood stasis in varicose veins, with its attendant malnutrition, is quoted as the main cause of varicose ulcer. There is no doubt that the peripheral venous circulation in varicose veins is impeded, and this fact has been demonstrated by many investigators, namely De Takats, Quint and co-workers, and Shaefer who showed decreased oxygen values and increased carbon dioxide and non-protein nitrogen levels in blood taken from superficial varix.

However undue stress has been laid on this point in the etiology of varicose eczema and ulcer. This is demonstrated by Figures 6 and 7 in which even though patient was relatively immobile and in the upright posture, the leg had almost completely left the lower leg in less than 30 seconds. We have all seen many cases in which severe accumulated incompetent veins were present for many years with few symptoms and no ulcer.

Undoubtedly this chronic tissue malnutrition is the basis for the chronicity of varicose ulcer because on proper removal or ligation and injection of the associated veins the condition heals.



Fig 4



Fig 5



Fig 6

Fig 5 This patient had had a thrombosis of the great saphenous vein produced by injections years ago. She returned complaining of the formation of new veins. The injection given into the great saphenous vein has been diverted into collaterals. A small part lower in the great saphenous vein appears to have recanalized. The injection fluid left the leg in less than 30 seconds.

Fig 6 A very severe case of varicose veins showing, besides the usual features, a well outlined popliteal vein and an incompetent small saphenous vein filling from it. The marked degree of involvement and tortuosity of the involved collaterals is also shown.

with remarkable rapidity. However, associated infection in the pre-ulcer area is the actual cause, whether introduced from an abrasion, a broken vein, or the scratching of a patch of eczema.

In the series here mentioned of 22 cases of varicose veins associated with ulcer, the majority healed in 3 weeks, the longest taking 7 weeks. This latter case had had an ulcer for 33 years which had never healed despite all the known conservative methods of treatment. The healing time after the operation of ligation and injection is directly dependent on the length of existence of the ulcer, a longer time being necessary when the surrounding skin is board-like and shows marked devitalization.

VENOGRAPHY

The visualization by means of x-ray of the venous circulation in the superficial veins of the leg has been attempted many times in the past 10 years. The earlier investigators used lipiodol (Quero and Robau, McPheeters, Barber and Orlev), but this had the disadvantage of remaining in globules and not giving a homogeneous outline of the veins. Since the introduction of more diffusible preparations, namely thorotrast and the iodine compounds used for intravenous urography, there have been sporadic illustrations of venography in the literature. However, I have been unable to find any articles dealing with the x-ray visualization of varicose veins, in which

any definite series has been investigated. Barber and Camp have written an excellent paper illustrating the uses of direct venography but have combined themselves to obstructive venous lesions. The radio-opaque solution used in their series was diodrast, with which they claim complete satisfaction.

Fourteen cases selected from the clinic were injected with a medium opaque to the x-ray in order to visualize the extent and communications of their varicose veins. The solution used was Hippuran (20 c.c.m.) and resulted in no ill effects in those cases which were kept ambulatory. One case selected from the ward patients for a normal control developed postinjection phlebitis in the great saphenous vein, which resulted in one large and several small pulmonary emboli. After the third such the saphenofemoral junction was explored and a thrombus was found projecting into the femoral from the saphenous vein and extending up the former for about an inch. The femoral vein distal to the saphenofemoral junction was blocked with clots.

After removal of the proximal segment of the thrombus *in toto* and ligation of the femoral vein at the saphenofemoral level the patient recovered with no further evidence of emboli. The development of the thrombosis in this case may be explained by the fact that she was not kept actively ambulatory following the injection.

Figures 1 and 2 show the results in normal cases. There was no evidence radiologically or clinically of varicose veins. The injections were made into the great saphenous vein at the ankle with the patient standing. The solution can be seen ascending as one would expect in veins with normal valves. The veins show normal small caliber run in almost straight lines, and show no tortuosity or dilatations.

Those cases with varicose veins which were selected showed clinically either Trendelenburg single or double test; consequently the injection was made at the level of the knee with the patient standing immobile. Invariably the solution was seen to descend toward the foot outlining the main vein and all its numerous dilated collaterals, and to disappear into the deep circulation through the communicating veins. Within 30 seconds following the completion of the injection and the first picture the leg was turned to the side for lateral view and it was seen that the majority or all of the solution had left the lower leg. In a few of the pictures the popliteal vein could be faintly seen of greater caliber than one would expect, but showing no dilatations or tortuosity. It is reasonable to suppose that the

deep veins in case of varicose veins are dilated because of the increased load put on them by the reversal of flow in the superficial circulation.

Venography in varicose veins would appear to have little clinical use and was done in these instances to substantiate graphically the changes in circulation in the varicose extremity.

PRactical Applications

As a result of our investigations and the conclusions therefrom the following methods of treatment of varicose veins have been adopted in our clinic, whether the complications of ulcer and eczema are present or not.

1. In cases of dilated veins when the Trendelenburg tests are negative or doubtful, local injections of sodium morrhuate or quinine and urethane are used.

2. In cases showing only a positive Trendelenburg single test, a ligation of the great saphenous vein is done at the saphenofemoral junction after ligation of the superficial tributaries which join the vein in that region. A distal injection of 4 to 6 cubic centimeters of 1 per cent sodium morrhuate is given into the open vein during the operation. This procedure has been described previously by Faxon, Ochsmier and Mahorner (10) Lowenberg and others. The patient is discharged home immediately after the operation and is kept ambulatory.

3. In cases showing a positive Trendelenburg double test—the group which contains the majority of ulcers and markedly involved veins—saphenofemoral junction ligation of the great saphenous vein is carried out with the distal injection as described. Also the small saphenous vein is ligated as deep in the popliteal space as it can be traced, and also injected distally with from 2 to 3 cubic centimeters of sodium morrhuate solution.

Summary

The past and present ideas of the causes of circulation in cases of varicose veins are discussed and the following points brought out.

Emphasis is placed on the basic importance of the reversal of flow in the great saphenous vein with patient in the erect posture with its bearing on treatment.

It is pointed out that the previous conception of the presence of incompetent valves in the communicating veins resulting in reverse flow is merely a supposition and is based on few actual facts. The presence of such valves is not substantiated by venographic studies of the leg. Consequently the extensive operative procedures designed for their obliteration are not justified.

RETROPHARYNGEAL INFECTIONS WITH ASSOCIATED HEMORRHAGES

A Rationale of Procedure for a Standardized Operation

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THE relatively rare occurrence of severe and fatal hemorrhage associated with retropharyngeal infections very often leaves the attending physician bewildered when he is confronted with such a condition. He too frequently finds himself helpless as his patient suddenly expires from exsanguination. Undoubtedly each year many patients are lost because of inadequate dissemination to our profession of knowledge of that simple procedure which has been proved most adequate in these catastrophes.

In reviewing the literature of this condition, one is impressed by the scarcity of material in text books and journals which might reach the average physician. Many of the articles submitted are reports of a few isolated cases, usually fatal with incomplete conclusions drawn. The most significant articles are those by Lebram in 1906, Newcomb in 1908, Lobbers in 1911, Stumpf in 1920, Sercey in 1928, Lifshutz in 1931, Le Mesurier in 1932, Skoog in 1932, Gerlings in 1933, Brauer in 1933, Sallinger and Pearlman in 1933, Stein in 1933, Goodyear in 1936, Fetterman and Pritchard in 1939.

Sallinger and Pearlman reported the collected case histories, treatment, and findings at necropsy in 31 cases and gave a complete review of this subject to date. Probably the most comprehensive pathological and bacteriological study of this condition is to be found in the article by Stein who submitted detailed reports of gross and microscopic studies from 14 autopsies which came under his own observation.

The pathological state which allows this serious complication to develop is one of severe infection of the retropharyngeal spaces. The invading organisms usually are of the streptococcal group although they are often associated with other flora from the mouth such as the *Bacillus fusiformis* and the *spirochaeta* (14). The severe hemorrhages which may follow are the result of secondary infection and erosion of the blood vessels traversing this infected area.

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It is evident that there is a very close anatomical relationship between the branches of the common carotid artery and the internal jugular vein with the abundant lymphatic system collected in these spaces. The numerous lymphatics which drain through this area must subject the region to constant infection of varying degrees. The more plentiful lymphatic system in children, as well as their greater susceptibility to upper respiratory disorders, limits these complications of retropharyngeal infections largely to childhood.

The blood vessels are involved by a process of direct extension. It is accepted that blood vessels have a remarkably high resistance to severe neighborhood infections, and succumb only after prolonged assault by virulent organisms. The veins usually react by thrombosis of the lumen. The arteries, however, seldom become thrombosed, probably because of their more thickened resistant coats, and the more rapid, pulsating flow of blood through them. Occasionally however there is complete direct infiltration through the arterial wall, with resultant rupture often through a pseudo-aneurismal sac. With the first leakage of blood, usually there is an increased swelling in the neck and retropharyngeal region. Swelling in the latter area often is wrongly interpreted as resulting from a retropharyngeal abscess and occasionally is opened, with disastrous results from sudden fatal hemorrhages. Within a few days the pressure of the infected blood ruptures through a small opening in the pharyngeal mucous membrane giving the first warning of approaching danger. As the small opening in the pharyngeal mucous membrane becomes larger there is release of the internal pressure provided by clots, etc. Within the closed retropharyngeal space which previously controlled the hemorrhage. With this release more profuse and often fatal hemorrhage occurs. The records reported show that these severe and fatal hemorrhages usually have been preceded by slight discharge of blood. The hemorrhage generally occurs from the pharynx although 87 per cent of the cases reported the blood escaped directly into the internal or external auditory canal.

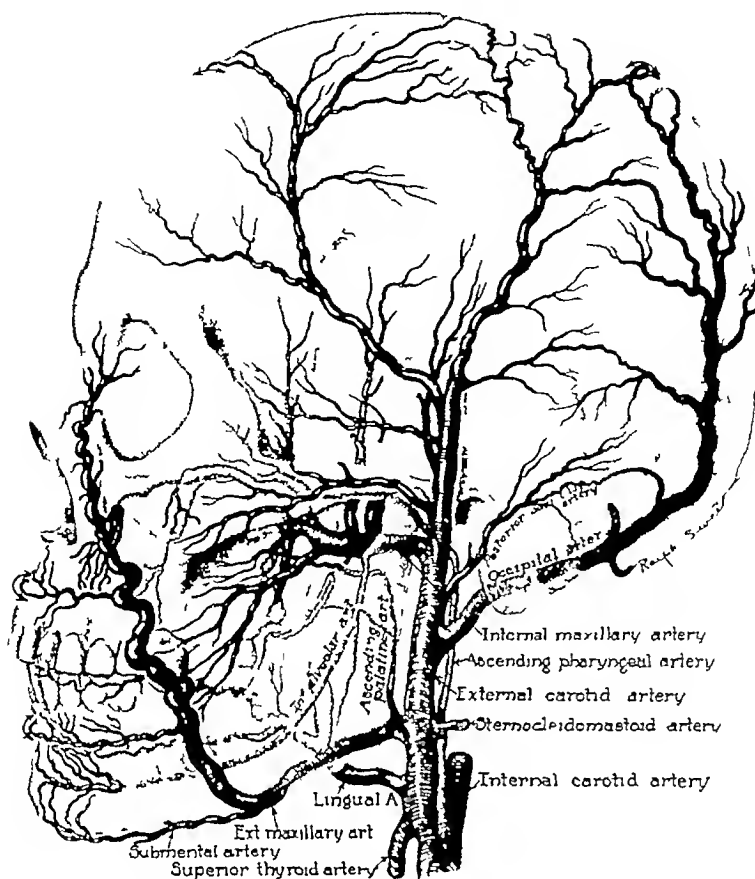


Fig 1 External carotid artery, showing abundant collateral circulation with opposite external carotid

In a series of 76 autopsies (11), in which death was proved to have been the result of erosion of a large vessel, either the internal carotid or the common carotid artery was "eroded" in 76 per cent, while the external carotid and its branches were the sources of hemorrhage in only 24 per cent

Studies made at autopsy (14) show that, while the internal carotid very frequently is involved directly, hemorrhage from the external carotid usually arises in one of its several branches. The closer association of the lymphatic glands with the internal carotid and the branches of the external carotid artery probably accounts for the more frequent involvement of these vessels

CASE REPORTS

CASE 1 S B, male, aged 9 years, was seen on April 15 1935 in consultation with Drs. Clain F. Gelston and Wallace Smith at Children's Hospital, San Francisco

On April 8, 1935, the patient complained of a stiff neck and sore throat. A tender, hard swelling the size of a bean developed behind the angle of the right mandible. His temperature was 103.5 degrees F. Two days later, he developed the typical rash of scarlet fever. On the seventh day of his illness (April 15), while he was drinking some milk, the patient had his first pharyngeal hemorrhage, estimated at 300 cubic centimeters and was taken to the hospital immediately. Blood analysis showed hemoglobin, 70 per cent, red blood cell, 3,470,000, white blood cell, 14,500, with 88 per cent polymorphonuclear cells.

Physical examination at this time revealed a rather sick boy. In addition to the findings noted there was a swelling in the posterior pharynx and a blood clot extruded through a small opening behind the right posterior pillar.

The right external carotid artery was immediately ligated and severed in continuity. This was carried out under nitrous oxide anesthesia.

On the following day the blood pressure was 140/60, and temperature 102 degrees F. At 6 p.m. a fresh hemorrhage occurred, and the opening in the pharynx had become wider. At this time the hemoglobin was 48 per cent, red blood cells, 3,200,000, white blood cells, 12,500, with 90 per cent polymorphonuclear cells.

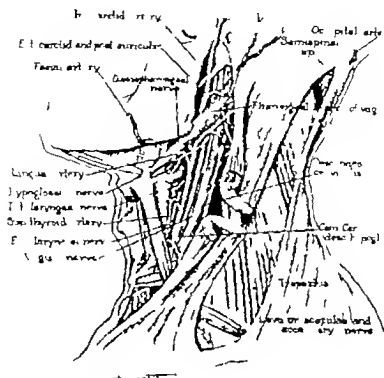


Fig. 1. Anatomical exposure showing essential structures encountered in exposure of the common carotid artery.

Under nitrous oxide anesthesia, the right common carotid artery as then ligated and severed in capsule, and transfusion of 300 cubic centimeters of whole blood as given. On April 4, the fifteenth day of his illness, there was sudden hemorrhage amounting to 500 cubic centimeters. The pulse became rapid and weak, the child as kept under sedation. The next day the findings were: temperature 39 degrees F, pulse 140, blood pressure 90/50, hemoglobin 15 percent, red blood cells 3,000,000, white blood cells 6,400 per cent polymorphonuclear cells. Marked pulsation as noted the site of the ligated external carotid artery. Exudate from the supporting neck wound as cultured and showed streptococci. The patient as kept quiet with sedatives. On April 26, his blood pressure as 90/50, and temperature 38 degrees F. The child as restless. At 4:30 p.m. an almost exsanguinating hemorrhage of over 500 cubic centimeters occurred. The patient as pulseless, unconscious, and mildly convulsed. A transfusion of 50 cubic centimeters of whole blood as given immediately. His temporary recovery. Seven hours later a second transfusion of 300 cubic centimeters of whole blood as given, and under light nitrous oxide anesthesia the operation as again explored.

It as found that the previously ligated common carotid artery as collapsed. The distal stump and remaining por-

tion of the external carotid artery and its branches had enlarged greatly (diameter 7.5 cm.) as result of collateral circulation which had developed from the opposite external carotid artery. This distal trunk of the external carotid artery as completely nicked after the major branches are ligated. The patient's recovery as rapid and complete. Almost residual disability except for slight Horner's syndrome which gradually disappeared entirely.

CASE 2. A G. male, aged 8 years, as seen at home on March 27, 1930, in consultation with Dr. Walter Hirschman. In the early part of March, 1930, the patient had an attack of acute tonsillitis. His submaxillary lymphadenitis. Under treatment, the tonsils subsided, but the adenitis persisted. The submaxillary and anterior chain of cervical lymph nodes persisted as slight, tender discrete, movable masses varying in size from 1 to 2 centimeters in diameter. The patient had low grade fever, varying from normal to 100 degrees F. by mouth. He as treated at home as bed by usual conservative measures, including local applications of moist heat. No sulfanamide as used.

The patient's temperature having become normal after about 14 days, he as allowed to get up. On the afternoon of March 31, 1930, he as taken to the home for the first time when he experienced small amount of bright

red blood. He lay down for 2 hours when, at 4 p.m., he had a sudden severe hemorrhage from the mouth of about 500 cubic centimeters. He was taken to St. Joseph's Hospital at once, where his blood count showed hemoglobin, 64 per cent, red blood cells, 3,375,000, white blood cells, 25,200, 84 per cent polymorphonuclear cells.

Examination at this time revealed the classical findings of acute hemorrhage, and on the right posterior pharyngeal wall a small exuberance of granulation tissue, resembling a rose bud, in the center of which was a clot of blood. Fresh blood was present in the oral cavity. There was no evident edema or sign of inflammation in the pharynx. The tonsils were moderately enlarged and chronically infected. The submaxillary and cervical lymph nodes were as here described. The temperature was 99.8 degrees F rectally, pulse, 128, and respiration, 24.

Operation was performed the same day under gas and ether anesthesia. After the superficial veins were divided, the common carotid, ascending pharyngeal, superior thyroid, lingual, facial, posterior auricular, occipital and terminal portion of the external carotid were ligated and divided.

The postoperative course was uneventful. The wound healed *per primam*. A low grade fever persisted until the day before discharge on the tenth postoperative day. Anti-anemic measures were instituted.

TREATMENT

In view of the past experience and errors of competent observers, it is generally conceded that these fatal hemorrhages arise from some major branch of the common carotid artery. It is also believed that the internal carotid probably is involved most often (in 76 per cent of cases), although autopsy records show that the external carotid or, more often, its branches, and the ascending palatine artery, are frequently the source of bleeding (in 24 per cent of cases). If we acknowledge these proved facts, the only rational therapy is prompt ligation of the artery involved, proximal to the source of the hemorrhage. This ligation offers the best assurance against recurrent fatal hemorrhages and propulsion of fatal emboli to the brain. Any patient with retropharyngeal infection presenting the complication of slight bleeding from the pharynx or ear should have prompt ligation of the carotid artery before the inevitable exsanguinating hemorrhage occurs. Any attempt to arrest the bleeding through the pharynx usually is meddlesome surgery.

In a given case, which artery should be ligated? It is impracticable to expose adequately all the vessels which might be eroded in the retropharyngeal spaces in order to visualize the bleeding point. In these acutely ill patients the region is obscured by enlarged lymphatic glands and surrounding infiltrated tissue, a condition which contra-indicates any unnecessary dissection.

Under light nitrous oxide or local anesthesia the common carotid artery and its major branches can be exposed easily (Figs. 2 and 3). The internal

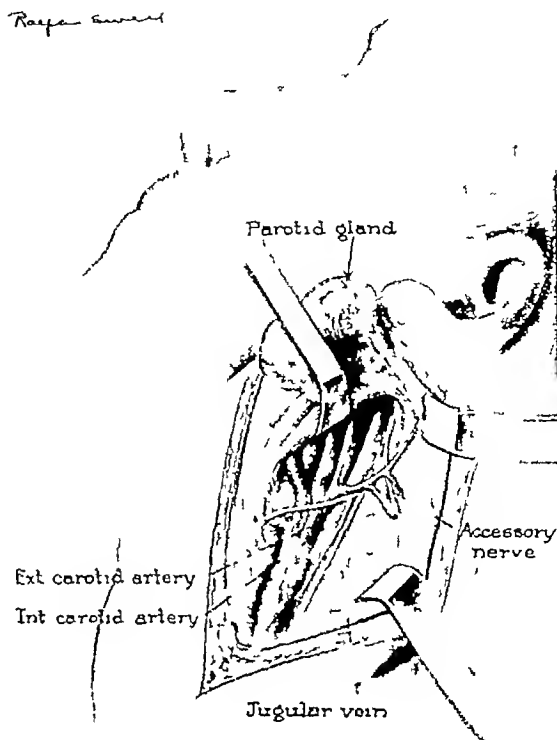


Fig. 3 Surgical approach to the common carotid artery

carotid artery can be visualized for a considerable distance, and the external carotid artery can be exposed so that its various major branches are visible. In very rare instances the portion of the artery actually eroded will be accessible, in which case the obvious treatment is ligation both proximally and distally.

If a vessel is to be ligated, it is generally conceded a better surgical principle to ligate it doubly and to sever the continuity of the vessel between the two ligatures. This procedure prevents the re-establishment of circulation, which often occurs when an artery is ligated in continuity. In addition to this ligation of the main artery, it is safer also to ligate its major branches in order to prevent an annoying collateral circulation which usually establishes itself within 7 days. Such a newly established collateral circulation has been proved to be the cause of recurrent hemorrhages and of cerebral complications resulting from the dislodgment of thrombi originating in the main trunk (3).

The incidence of hemiplegia following ligation of the common or internal carotid artery (2), while a serious complication in adults, is negligible in children. The child has a very abundant

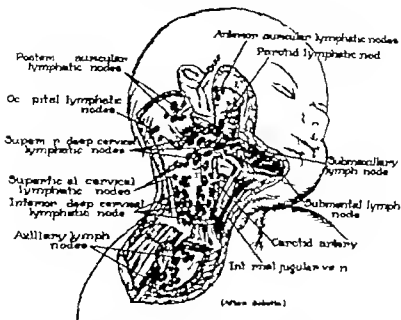


Fig. 4. Deep and superficial lymphatics. After Sobotta.

collateral circulation through more elastic and less tortuous arteries. The necessity for controlling an otherwise fatal hemorrhage more than offsets the very slight danger of incurring cerebral complications.

The author feels that all ligations should be accomplished at the first operation if possible. At any secondary procedure, the operative field is masked by fibrin and streptococcal suppuration, and this masking makes dissection and identification of important anatomical structures both difficult and surgically hazardous.

On account of the very limited experience of any one surgeon in this particular disease a standardized technique has not yet been established. Three possible sites for ligation have been described, with arguments for and against them.

Primary ligation of the common carotid artery

Technically this operation is the most simple on account of the low cervical location of the operative field, which affords easy exposure of the common carotid artery. Theoretically ligation of the common carotid artery should be adequate to control distal hemorrhage in either external or internal branches and in the ascending palatine artery. Practically, however, ligation of this artery has proved inadequate because of the abundant collateral circulation between the external and internal branches and the site of bifurcation of the common carotid artery.

2. Ligation of the internal carotid artery alone

Much evidence (11, 4) points to the internal carotid artery as being the vessel eroded in most instances (76 per cent). If we could be absolutely certain that the bleeding was from the internal carotid artery it is obvious that its ligation should suffice. There is, however, possibility in 24 per cent (1-4) of cases that the hemorrhage is not from the internal carotid, and hence in such cases its ligation alone would be valueless.

3. Ligation of the external carotid artery alone

Here again for lack of evidence, we are not warranted in assuming that the obscure hemorrhage arises from the external carotid artery. Our chances of an error are 76 per cent (1-4). Even were we correct in ligating only the external carotid artery it is evident that the collateral circulation from the opposite side may re-establish the hemorrhage as illustrated by Case 1 in which primary ligation of the major branches could have voided the third hemorrhage. In view of the experience in Case 1 a fourth technique is suggested which seems to be more logical procedure in the presence of uncertainty as to the source of hemorrhage and which was practiced in Case 3 as reported. Because of the evident difficulty in determining before operation the exact source of the hemorrhage and also because of the more frequent incidence of involvement of the internal carotid artery it is probably better judg-

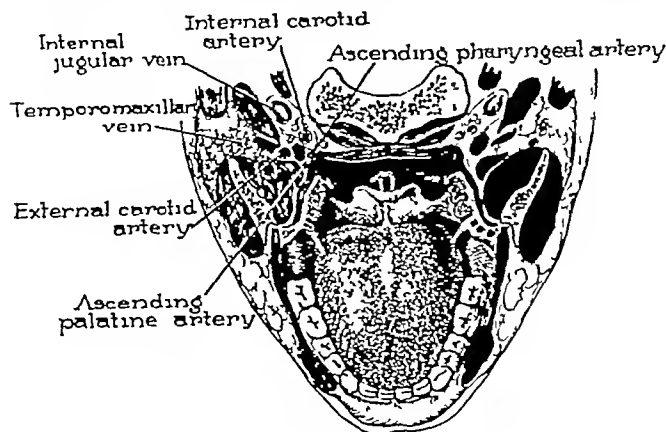


Fig 5 Horizontal section through mouth and pharynx at level of tonsils After Goodyear

ment to ligate the common and external arteries, together with the major branches of the latter

4 *Ligation of the common carotid artery, the external carotid artery, and the major branches of the external carotid artery* In view of our experience in Case 1, the author recommends this procedure as a prophylactic measure at the original operation, as illustrated in Case 2 This assures control of bleeding, whatever the source, and at the same time eliminates the possibility of recurrent hemorrhages through collateral circulation from the opposite carotid artery In our first patient, we assume that the first hemorrhage arose from the external carotid artery and was controlled by ligation of this artery The second hemorrhage after 36 hours probably issued from the internal carotid or from the ascending palatine artery and was controlled by ligation of the common carotid artery The third, and almost exsanguinating hemorrhage 7 days later, undoubtedly was the result of abundant collateral circulation through the opposite external carotid artery This assumption is based on the fact that at the third operation the previously ligated common carotid artery was found to be collapsed, while the severed distal end of the external carotid artery and its branches was markedly dilated throughout This third hemorrhage was controlled by ligation of the branches of the external carotid artery

These ligations, as shown in the accompanying diagrams, require a negligible increase in the time needed for operation and produce little or no additional shock to the patient An excellent exposure of the common carotid artery and its major branches is achieved through an incision beginning at the mastoid process and developed

along the anterior border of the sternomastoid muscle (Figs 2 and 3) Such a technique of primary multiple ligations would have avoided the last two operations in Case 1 These multiple ligations of the common carotid artery, as well as of the external carotid and its major branches, were the composite technique which undoubtedly saved the patient's life The clinical risks and surgical difficulties encountered in these 3 separate operations could easily have been avoided had the multiple ligations been performed in one stage, as reported in Case 2

As a conservative concession to this radical procedure, the author suggests (a) An excision of the external carotid by ligation of all its branches, (b) a heavy silk ligature placed about the internal carotid with its ends brought out through the wound, this ligature to be immediately tied if further bleeding occurs from the internal carotid artery

SUMMARY AND CONCLUSIONS

1 Retropharyngeal infection is likely to cause erosion of some branch of the common carotid artery

2 Any patient with such an infection, who has even a slight hemorrhage from the pharynx or auditory canal, requires immediate ligation of the common carotid artery and its branches

3 The possible types of ligation in the condition under discussion are reviewed, and the following procedure is recommended at the initial operation Ligation of (a) the external carotid artery, (b) all major branches of the external carotid artery, (c) the internal carotid artery This may be deferred by placing a silk ligature for secondary ligation, if necessary

4. The same surgical principles are involved in controlling hemorrhages from other sources as a result of malignancy, trauma, gunshot wounds and other lesions.

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RUBBER HEELS FOR WALKING CASTS

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SINCE the introduction of walking casts, many varieties of attachments to provide the weight bearing surface have been devised. After trying many of them we find the one here illustrated most satisfactory from the standpoint of economy, appearance, ease of application, and efficiency. It consists of an entire heel, leather and rubber, applied to the bottom of a reinforced cast, and held in place by means of webbing attached to the heel and incorporated in the plaster.

Rubber heels are cheap. Every shoe store and appliance shop has a basket full which have been removed from shoes for replacement by Thomas heels. They are easily applied at one sitting, no drying period between the application of the cast and the heel is necessary, and no bending irons are required.

From the Orthopedic Service, Department of Surgery, University of Michigan

The finished cast is smooth and neat in appearance. A stocking may be slipped over the cast and a hole cut for the heel.

In winter a wool sock or an overshoe can be worn.

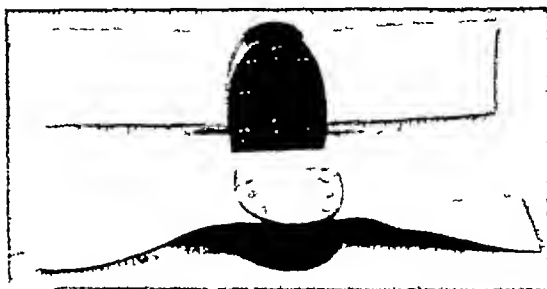


Fig 4 Details of construction of heel. The top layer of leather is pried off, the webbing inserted, the leather re applied, and the nails turned down.



Fig 1

Fig 1. A light, skin tight cast is applied with foot at right angle, lined only at margin with stockinette.



Fig 2

Fig 2. Sole is reinforced, hollow of arch filled in, and surface flattened for the application of the heel which is placed just back of mid foot on a plane that is at right

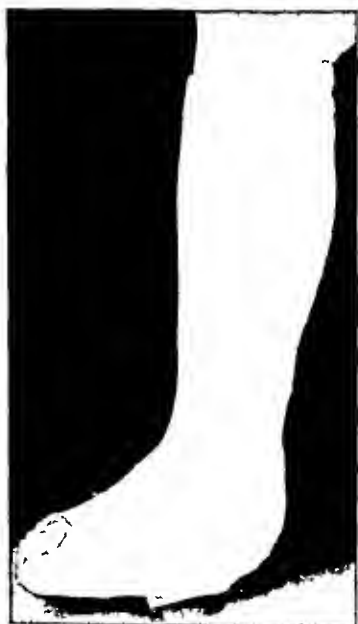


Fig 3

angles to the weight bearing line.

Fig 3. Heel fastened in place with a few more turns of plaster bandage. Weight bearing is allowed after 24 hours if cast is thoroughly dried. If a long leg cast is used, the heel and sole are built up on the opposite shoe.

Patients who have also worn the various modifications of the Boehler iron prefer the rubber heels because there is sufficient bearing surface to give them a good grip on the floor for stability and still allow a rocker motion in walking.

Care should be exercised to put the foot in the cast at right angles to avoid striking the ball of the foot on the floor in walking. One roll of plaster is sufficient to reinforce the bottom surface

and fill in the hollow of the arch. The flat surface thus provided for the heel should be at right angles to the weight bearing line. If a long leg cast is used, the heel and sole of the opposite shoe are built up $\frac{1}{4}$ inch.

After using more than 100 of this type of weight bearing casts in various types of corrective arthritic, traumatic, postoperative, and infectious cases, we feel justified in recommending it to the profession.

THE TREATMENT OF VARICOSE VEINS BY HIGH DIVISION AND RETROGRADE INJECTION

A Review of 135 Late End Results

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SINCE the statement by Homans, in 1906 Varicose veins and their attendant ulcers have long offered and may continue to offer a fruitful field for surgical failures, and this not so much from the lack of effective weapons in the surgeon's armamentarium as from his failure to choose his weapon according to the strength of his opponent, the pendulum of therapy has swung widely, particularly during the past decade (5).

After a long period of radical surgical procedures including excision and stripping, an era of non-operative or simple injection treatment was ushered in with eagerness and satisfaction. Thus, radical surgery frequently associated with serious complications and long costly hospitalization was abandoned for a relatively safe ambulatory method.

Careful studies soon demonstrated an enormous percentage of recurrences after simple injections, particularly in those cases in which there was extensive dilation in the saphenous system above the knee. The cause of this rapid recurrence was obvious when one considered that the injection treatment could not affect the major source of leakage at the saphenofemoral junction.

It was inevitable therefore that the importance of high interruption of the saphenous vein should be recognized anew and combined with

the injection treatment. The correction of back pressure was again shown to be the most important single factor in treatment. Homans, in 1916 had stressed this principle in connection with the radical operative methods in vogue at that time. Retrograde injection complements the ligation; it obliterates the trunk in the thigh and lessens the number of injections needed below the knee.

Treatment, based upon these principles, was begun in the vascular clinic of Beth Israel Hospital in late 1932. In this paper we propose to make a survey of 35 extremities treated in this manner for the purpose of evaluating those which proved failures.

The selection of cases, method of examination, contraindications, etc. have been adequately reported (7) and need no elaboration in this paper. We are describing our technique in detail, however, because of its obvious bearing on end-results (Fig. 1).

TECHNIQUE

After adequate preliminary sedation, the operation is performed under a local anesthetic of per cent novocain with adrenalin. The intradermal infiltration is begun over the femoral pulsation about $\frac{1}{2}$ centimeter below the crease in the groin, and extends medially parallel to this crease for a distance of 4 to 5 centimeters. The incision is carried down through subcutaneous fat and superficial fascia. Then, by careful

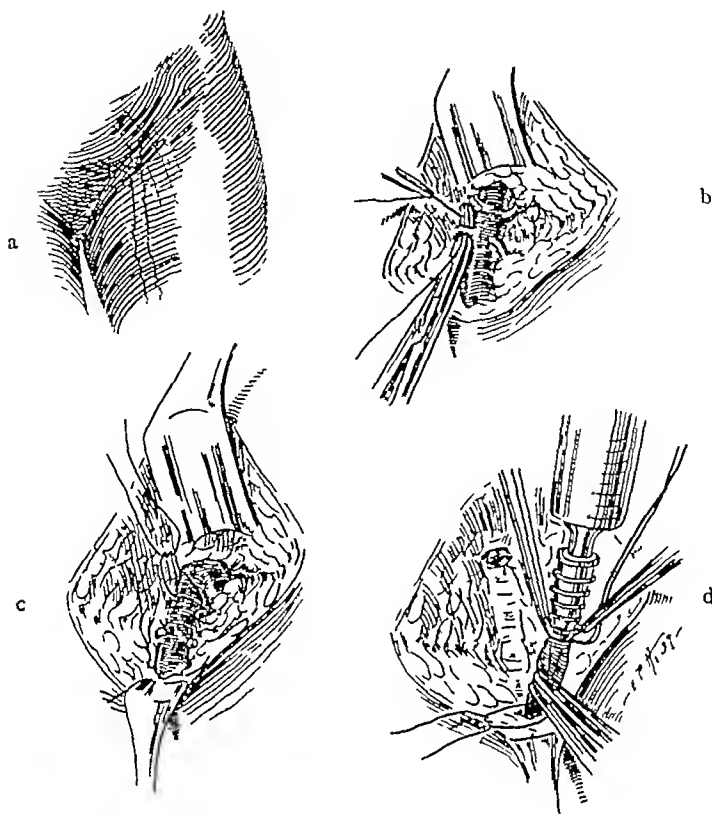


Fig 1 Operative technique a, Incision 0.5 centimeter below crease in groin, b, ligation of all tributaries, c, ligation at saphenofemoral junction, d, injection down distal stump

scissor dissection, the saphenous vein is usually found in the medial portion of the wound

A ligature or tape may be placed about the vein for traction while the vessel is dissected upward and downward. From 2 to 12, usually an average of 5, tributaries have been found entering the saphenous vein, chiefly just before and at the point where the vein passes through the fossa ovalis. All of these tributaries are severed between fine silk or plain No. 00 catgut ligatures. The saphenous vein is doubly ligated, above the highest tributary, at or near the saphenofemoral junction with heavy silk or No. 0 chromic catgut.

The vein is thoroughly exposed in the lower portion of the wound and any tributaries are ligated and severed. The wound thus contains a segment of vein about 4 to 6 centimeters long. The upper two-thirds of this segment is excised and a special Faxon grooved cannula is tied into the open end. Loss of 20 to 30 cubic centimeters of blood through the open end of the vein may be

of some value in connection with the subsequent chemical sclerosis.

The wound must be protected by wet gauze against the accidental spillage of sclerosing solution. Depending upon the size of the varices, 10 to 30 cubic centimeters of varisol¹ is injected slowly and with slight pressure. The solution will exert its effect chiefly on the saphenous vein in the thigh if an assistant maintains pressure over the saphenous vein in the region of the knee² for 5 minutes.

After the injection, before the cannula and syringe are removed, a right-angled clamp is placed across the vein just below the tip of the cannula. The vein is doubly ligated $\frac{1}{4}$ centimeter below the clamp. If the vein is cut along the lower border of the clamp, no leakage takes place, the clamp, cannula, and syringe are re-

¹Formula, 30 per cent ioverl sugar, 10 per cent sodium chloride and 1 per cent benzyl carbinol (Abbott).

²Alternate method. Apply a woven bandage from toes to knee prior to the operation.

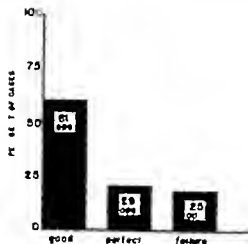


Fig. End-results of 33 high ligation with retrograde injection studied to 6 years after operation.

moved as a unit. The wound is flushed with warm salt solution and then closed.

Postoperative care. At the conclusion of the operation, the extremity is elevated, and the thigh, leg, and foot muscles are exercised. After being transferred to bed, the patient is encouraged to elevate and move the leg frequently but we have not insisted that the patient be ambulatory immediately. On the afternoon of the day of operation the patient is up and about and is usually discharged the next morning.

In about 80 per cent of these patients the saphenous trunk in the thigh is thrombosed at the time of discharge and, in many this is noted at the conclusion of the operation. This thrombosis we assume to be associated with more extensive intimal damage, and, therefore, more lasting than the thrombosis which results from the injection of lesser amounts of sclerosing solution, e.g. 1 to 2 cubic centimeters of sodium morrhuate.

The patient is instructed to continue activity and to wear supporting bandages after discharge from the hospital. One week later the patient returns to the out patient clinic for removal of sutures and for the first of any injections needed in the leg or lower thigh. On the average 3 to 4 injections are required for each extremity. A small number of patients need no injections because of thrombosis of the saphenous vein from groin to ankle.

METHOD OF END-RESULT STUDY

Letters were sent to all patients who had been subjected to this procedure at least to 6 years

previously. In response to 130 requests, 18 were returned because of wrong address, 25 were ignored, and 87 patients, representing 135 operations, reported. Each was questioned concerning relief of symptoms and the entire lower extremity was carefully inspected and tested by palpation, tap and tourniquet test.

We were concerned chiefly with anatomical end-results, inasmuch as symptomatic relief usually followed obliteration of the varicose system.

End-results. We have separated our results (Fig. 3) into 3 arbitrary groups as follows:

1. Perfect signifies that the extremity was entirely free from varicose veins. Obliteration was complete in the major system and all its varicose tributaries. There were 20 extremities or 21.4 per cent in this group.

2. Good denotes that the great saphenous system was entirely thrombosed but that there was some dilation and stagnation in tributary veins or segments of the latter. This may have been due to recurrence, inadequate follow-up injections or the formation of new varicosities from previously uninvolved veins. In any event, the situation could be remedied by a few injections. Anatomically and symptomatically these were satisfactory end-results. There were 81 extremities or 60 per cent in this class.

3. Failure includes any extremity in which a greater or lesser portion of the great saphenous vein itself was patent, and of course any case in which there was persistence or recurrence of ulcer. In some, the entire vein contained blood despite a lessened diameter and a partial or complete absence of symptoms. In others, the segment containing stagnant blood was not more than to 3 inches long. This group consisted of 5 extremities or 18.5 per cent and included 5 recurrent or persistent ulcers.

CAUSES OF FAILURE

An analysis of our failures revealed definite reasons in the majority of instances, and many were avoidable.

1. **Fully technique (instances).** In none of our cases could we find evidence of backflow via a tributary above the point of ligation. In 1 of our obese patients the house surgeon did not find the saphenous vein and the patient refused reoperation. Another it was obvious that recurrence was due to failure to sever an atypical tributary which connected the saphenous vein with a large suprapubic varix.

2. **Incompetent communicating veins (3 instances).** Damage to the valves of 1 of the veins

which connect the deep and superficial systems will result in a reversal of blood flow through the communicating or perforating vein. The flow will then be from the deep to the superficial system. This reversed flow constitutes an abnormal head of pressure which is not affected by high ligation, but which itself may hasten recanalization in the thrombosed superficial system. These incompetent communicating veins usually follow deep phlebitis and are found most frequently in the lower leg, we have found them less frequently in the lower and mid thigh.

Inadequate obliteration of an incompetent short saphenous system, associated with varicosity of the long saphenous system, may cause failure, although there was no instance in our series. The mechanism is not unlike that referred to in the preceding paragraph, for indeed the short saphenous vein perforates the fascia and enters the deep system. We have ligated such markedly dilated short saphenous systems in the popliteal space.

3 *Inadequate postoperative injections (9 instances)* Inasmuch as high ligation and obliteration of the varices by injection complement each other, it was to be expected that we would find failures among those who did not return for completion of the sclerosing process. Our survey revealed that 6 did not return because of the relief afforded by the ligation itself, 2 lived in distant communities and failed to visit their family physician for the injections. In 1 patient injection was precluded by a diffuse eczema.

4 *Pregnancy (3 instances)* The effect of subsequent pregnancy on high ligation is not uniform and will be reported in another paper. Two of the women who came back for this follow-up were in the last trimester of pregnancy. Marked varicosities were seen on 3 extremities and moderate varicosities on 1 extremity. It would appear, then, that pregnancy may cause failure, although only temporary in some.

5 *Unknown (8 instances)* We were unable, either by study of the record or physical examination, to determine the cause of failure in this group.

EVALUATION

Eleven or 44 per cent of our 25 failures were probably avoidable, namely, those due to inadequate surgery or insufficient postoperative injections.

The 3 failures associated with incompetent communicating veins, if the latter were present before operation, might possibly have been avoided by a more careful performance or interpretation of the tourniquet test. Can the method of

treatment, however, cause incompetency of these communicating veins? It is conceivable that sclerosing solution, injected into the saphenous vein at the time of operation, may enter a previously normal communicating vein in a concentration sufficient to damage the latter's valves, with the eventual deleterious effect on the superficial system herein described. The following history is pertinent to this problem.

Mrs S. M., aged 37 years. On October 10, 1934, a left high ligation with retrograde injection was done, 8 tributaries were ligated and divided. When she reported at the vascular clinic for routine postoperative check-up, no injections were given because the saphenous system was completely thrombosed. On July 17, 1936, she was rechecked and her extremity was described as "excellent except for an occasional small, dilated, superficial vein." On February 7, 1938, recurrence was noted in the entire saphenous vein up to 2 inches of the operative scar. The saphenous system, although completely filled by a regurgitant column of blood, was less dilated than before the original high ligation, it was likewise the source of less discomfort. Re-operation on May 6, 1938, revealed the source of the reflux to be a communicating vein about 1½ inches below the previously ligated distal stump of the saphenous vein. It is possible that this communicating vein was not incompetent at the time of the first operation and that its valve system was injured by the sclerosing solution.

The group of 8 failures of "unknown" cause and representing 59 per cent of all the operations deserves special concern. We have already emphasized the important fact that new varices may appear in previously normal tributaries, regardless of the extent or type of therapy. This is one of the reasons why the majority of our end-results are "good" rather than "perfect." But a failure due to the re-opening of portions of the thrombosed main trunk itself, after high ligation and injection, and in the absence of incompetent communicating veins, implies an inherent weakness in our method.

Of great significance, in this connection, are the studies (4, 6, 9), which show how a chemically thrombosed segment re-opens, in contradistinction to the natural reparative processes which follow postoperative, traumatic, or so called spontaneous thrombosis. Sections of a varicose vein removed 24 to 48 hours after injection, regardless of the solution, show that the solid mass filling the vein varies in firmness and structure in different portions of a single specimen. Deposition thrombus, attached to damaged intima, forms the smaller portion of the total occluding mass while the larger portion consists of simple, unattached coagulation thrombus and usually is in relation to undamaged intima. If retraction of the clot is so extensive that the resulting space communicates between 2 tributaries opening into

the principal lumen the vessel once again is part of the active circulation with the potentiality of undergoing still further varicose dilation. In other specimens, it was observed that solid buds of proliferating endothelium from uninjured intima grow into organizing thrombi and form sinuses which become confluent and so re-establish the lumen of the vessel.

Pratt has reported a technique which may be helpful in certain cases. He distributes the sclerosing solution equally throughout the vein length via a ureteral type of catheter introduced for a distance of 40 to 60 centimeters.

Thus, more permanent obliteration and a better result may follow any method which causes uniform intimal damage with a resultant continuous and diffusely attached thrombosis.

SUMMARY AND CONCLUSION

1. One hundred and thirty-five extremities in 87 patients were studied 2 to 6 years after high ligation and retrograde injection for varicose veins.

2. A classification of anatomical end-results as (1) perfect, (2) good, and (3) failure is presented. Twenty-one and four tenths per cent were perfect, 60 per cent were good, and 18.5 per cent were failures of the latter almost half were probably avoidable.

3. The causes of failure are discussed.

4. The combination of high ligation and retrograde injection is a satisfactory and adaptable method of treating marked varicosity of the saphenous system.

5. The treatment of varicose veins is still in a state of flux only by late end-result studies can present day enthusiasms be evaluated.

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EDITORIALS

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APRIL, 1940

FACTORS IN LOWERING MORTALITY IN THYROIDECTOMY FOR TOXIC GOITER

IT is agreed by all surgeons doing thyroid work that the mortality rate for thyroidectomy for thyrotoxicosis should be no greater than one per cent. However, there are perhaps numerous clinics where the mortality rate will be much higher than this. Occasionally this will be a matter of coincidence influenced by a small series. On other occasions it will be explained on the basis of lack of appreciation of the importance of prerequisites in thyroid surgery. It is a great advantage to the surgeon not to have iodine administered to the patient except during the two week interval previous to operation. Naturally, if iodine has been given for a period longer than three weeks, the optimum operability may have been lost.

Of the *prerequisites* for thyroidectomy, (1) administration of iodine for ten days to three weeks, (2) gain in weight, (3) lowering of

metabolic rate to 50 or below, (4) pulse rate below 110, and (5) decrease in symptoms, are the most important. In patients who are exceedingly toxic, a ten day interval of iodine preparation will be insufficient, very commonly the patient's condition will improve remarkably for a period as long as three weeks following administration of Lugol's therapy. One of the most important prerequisites is that the patient must be gaining in weight when he is operated on. To attain this gain a daily intake of 4,000 or 5,000 calories may be necessary. Rarely is it justifiable to perform thyroidectomy in the absence of a gain in weight. Exceptions might be legitimate when the toxicity is relatively mild. The prerequisite of having the basal metabolic rate below 50 at the time of operation is naturally somewhat arbitrary, particularly since on numerous occasions the basal metabolic rate will not be an accurate estimation of the degree of toxicity. As a general rule, however, attempt should be made to get the patient's basal metabolic rate below 50 before considering operation. The prerequisite of having the resting pulse rate below 110, is likewise somewhat arbitrary but it is a well known fact, at least in the writer's opinion, that patients whose pulse rate at rest is over 110 are apt to have a serious reaction following thyroidectomy. Patients with a marked degree of toxicity should have a definite improvement in symptoms. With very few exceptions, Lugol's therapy will bring about this improvement.

There will be instances occasionally when the patient's toxicity is out of control, and the prerequisites listed cannot be met. The surgeon should not give up in desperation and

submit the patient to thyroidectomy until he has observed the patient and utilized such principles as bed rest, unusually high caloric intake, sedation, etc., in the hope that a regression will take place. Almost always there will come a time when the toxicity will be reduced sufficiently so that operation will be comparatively safe. In patients who are exceedingly toxic it may be wise to perform thyroidectomy only on one side. It is the writer's opinion that this procedure will save many lives. This opinion is held by Lahey and many others. The decision as to whether one or both lobes should be removed is much more important than the operating technique itself in this group of toxic patients. If the pulse rate rises above 140 during removal of the first lobe, in the absence of the interference by anesthetic factors, the question of performing a thyroidectomy only on one side should be taken into consideration by the surgeon and anesthesiologist.

In the operative technique such principles as leaving the posterior capsule, abstaining from applying clamps near the trachea, etc., will eliminate a certain number of complications such as nerve injury, tetany, etc. All vessels must be tied tightly. Undoubtedly some instances of postoperative hemorrhage arise because of failure to tie a major vessel, but in other instances because the ligature became untied or was kicked off by a pulsating vessel. Large vessels such as the superior pole should be tied doubly. The question of using silk or catgut is open to dispute, but the writer favors the use of silk because of the formation of less serum after operation and because the post-operative course is slightly smoother. There is no question but that consideration of prerequisites such as those herein mentioned will diminish the operative mortality following thyroidectomy for thyrotoxicosis.

WARREN H. COLE.

ENDOMETRIOSIS

A CONDITION such as endometriosis which produces much disability and presents many difficult problems in treatment will continue to be a most interesting subject until its complex nature is understood more clearly. It is known that endometriosis is an abnormal growth of endometrial tissue in an ectopic position but it is not known exactly why some women are affected and not others. It is known too that 80 per cent of all patients seen who have endometriosis are between 30 and 50 years of age, that endometriosis becomes quiescent if the ovaries are removed surgically or their function destroyed by irradiation and that there is primary sterility in approximately 35 per cent of cases. It seems logical therefore to assume that in some women a factor exists which rigidly controls the endometrium in its normal position and causes it to become inactive when it is in an ectopic position. If this assumption were faulty then all women should have more or less endometriosis since endometrial cells do find their way into the peritoneal cavity at some time. It has been shown to the satisfaction of most gynecologists and physiologists that the activity of the endometrium is regulated by the hormones of the ovary—estrogen and progesterone, which are in turn under the control of the gonadotropic hormone of the pituitary. Anything that disturbs this normally balanced equation could seriously disturb the metabolism of the normal endometrium. It may be possible that this mechanism is congenitally defective in varying degrees and that endometriosis, as well as menstrual disturbance, is a direct heritage.

A rather direct relationship has been noted between the degree of cystic hyperplasia of the endometrium and the extent of the endometriosis. If cystic hyperplasia of the endo-

metrium denotes ovarian dysfunction or failure, then when cystic hyperplasia grade 3 or 4 is present and is associated with endometriosis clinically, the endometriosis may be assumed to be too extensive for conservative surgical treatment. Also, if the endometrium is nearly normal and there is clinical evidence of pelvic endometriosis, the chances of avoiding radical surgical measures are much greater. If observation of such relationships should be confirmed sufficiently often, it may become possible to determine from biopsy of the endometrium whether the ovary and uterus are rapidly becoming functionless. If such a condition is encountered even though the patient is in the latter part of the third decade or early in the fourth decade, panhysterectomy is the procedure of choice. The power to reproduce is almost certainly gone and ability to bring about normal menses by substitution therapy is essentially nil.

An observation which may have considerable influence in clarifying this subject was made by Dockerty who noted that exactly the same histological picture of the menstrual cycle as seen in the endometrium of the uterus can be seen in practically all endometrial implants. For instance, if the endometrium is in the proliferative or differentiative stage, it will appear the same in the implants. This seems to indicate strongly that endometrial implants are derived in some way from normal endometrium and not from metaplasia of the cells of the peritoneum or cell rests of the wolffian or muellerian ducts. This is additional evidence that the ectopic endometrium is under the same controlling influence as normally situated endometrium.

When endometrial implants involve the ovary and hemorrhage occurs, hemorrhagic or chocolate cysts are initiated. The implant is easy to locate in a tiny cyst, but is often difficult to find in a large chocolate cyst since

most of the repeated hemorrhages may be from one or more implants in or near the fixed portion of the cysts. These cysts must be differentiated from the hemorrhagic cysts of the corpus luteum. The latter are smaller and do not contain evidence of multiple hemorrhages within a cavity. The term "chocolate cyst," I believe, should be used to denote cysts of endometrial origin in contradistinction to the hemorrhagic cysts of the corpus luteum. A further distinguishing feature of the chocolate cyst is the extent of irritation or reaction in structures adjacent to the cyst and also the one or two rigidly fixed points of the cyst wall. If these points are carefully investigated, the endometrial implant will be found there if not in any other position.

Diffuse external endometriosis is often lacking when large bilateral chocolate cysts are present, and I suspect that it is for this reason that many gynecologists maintain that the chocolate cyst is not endometrial in origin. It is my belief that the patient with large chocolate cysts often has fewer implants and, therefore, less dysmenorrhea than the patient with endometriosis and very small or no chocolate cysts. Furthermore, the former seeks treatment for menstrual disturbance, the latter, for dysmenorrhea and often sterility.

The situation, projection, and distribution of the pain produced by endometriosis should be studied carefully for the pain is the one most important symptom which induces the patient to consult the physician. Disturbances in the amount or character of the menstrual flow are usually of secondary importance except when associated with large chocolate cysts and are seldom of enough significance to constitute the patient's primary complaint. An analysis of the distinctive symptom, pain, frequently indicates certain features which aid in diagnosing the location and the extent of the disease. Rivers in his

analysis of pain produced by a lesion in the gastro-intestinal tract has shown that two types of pain exist depending on the location and extent of the lesion. He pointed out that as long as the lesion is confined to a portion of the bowel only the pain is of visceral or sympathetic type and has no localizing symptoms, but if the lesion becomes penetrating or involves any adjacent tissue by inflammatory reaction the pain becomes somatic or spinal sensory in type. The pain then is referred over the course and extent of the spinal sensory nerve which projects to a particular segment of the trunk and can be localized in that region. A typical example of this is noted in acute appendicitis. The pain at the onset is generalized or visceral in type but when the inflammation spreads to the local peritoneum the distress becomes severe and localized over the right lower quadrant as a somatic or spinal sensory pain.

The pelvic viscera and adjacent peritoneum should portray the same visceral and somatic type of pain as abdominal viscera. There seems to be sufficient evidence to support this view. The pain of primary dysmenorrhea is a pure visceral or sympathetic type of pain, since nothing is involved but the contracting uterine musculature and the pain is designated

as uterine cramp. If dysmenorrhea has not existed previously but is acquired and if it becomes progressive invasion of the uterine wall by endometrial tissue should be suspected. The pain then becomes a more prolonged visceral type of pain. However it has been observed that if the endometrium is outside of the uterus itself the pain is more likely to be of a different character. For example endometrioma of the round ligament produces pain which is referred to the inguinal region where as endometriomas situated under the broad ligament and along the ovarian ligament produce pain which is referred to the groin and inner side of the thigh. This pain is purely somatic in type since the parietal peritoneum has become involved. Lesions of the rectosigmoid juncture cause distress which is referred to the anus and, when the endometrioma involves the mucous membrane of the rectum, there is a desire to defecate.

Finally if strict attention is given to the extent of cystic hyperplasia of the endometrium and the type of pain produced by the endometrial lesions is analyzed carefully it is possible to obtain a more accurate picture of the condition for consultation before treatment of any type is instituted.

VIRGIL S. COUNSELLER.

TEXTS AND DOCUMENTS

ARNO B. LUCKHARDT, M.D., Chicago, Illinois

THIS Journal proposes to print from time to time historical texts of an instructive and/or amusing character, the ensuing example being presumably of the latter type.

Most biographical articles are so written that the reader is left in a state of reverential awe for the subject of the biography, because of a sort of deification of his subject. We understand, of course, that the "hero" was born like other mortals but sense that it was on Mount Olympus with a hereditary halo of sanctity about him "*ab initio*." As human beings we usually look in vain for the mortal characteristics of the man or woman. If alluded to at all we usually find the worthy endowed with divine attributes acquired or developed to a high degree of perfection with the result that we visualize the hero walking through life not as a human being who lived and breathed like the rest of us but as one who of divine origin could not ever talk, live, and think, and act in a human or earthly manner.

It is therefore entertaining and refreshing to find an occasional account of a genius who walked this earth as a mortal and who had and contended with the same usual "*passiones animae*" (Descartes) that are characteristically human.

Such an account we discover in Aubrey's *William Harvey*. Of biographer Aubrey we know little except that he was apparently a genial and observant man, who remarks about himself "My head was always working, never idle, and even travelling, 'did glean some observations some whereof are to be valued'."

Aubrey's notes on the great Dr. William Harvey and other gentlemen were originally designed as memoranda for use of Anthony A. Wood when the latter was composing his "*Athenae Oxonienses*."

These notes never reached the hands of Anthony Wood or were neglected by him for the "*Athenae Oxonienses*" as published contains no biographical notice of William Harvey—undoubtedly the most illustrious of the favorite sons of Oxford.

The notes of Aubrey were found years later in the Bodleian Library and Ashmolean Museum and published by the printers under Aubrey's name with the title—"Letters written by Eminent Persons in the 17th and 18th Centuries. To which are added, Hearne's Journeys to Reading and to Whaddon Hall, the Seat of Browne Willis, Esq. and Lives of Eminent Men by John Aubrey, Esq. Printed for Longman, Hurst, Rees, Orme, and Brown, Paternoster Row, and Munday and Slatter, Oxford, 1813."

In the advertisement at the beginning of the first volume the publishers state that Aubrey's notes "are now submitted to the public as literary curiosities" and that "some passages, either too trifling, or too gross, for publication, are omitted" (Sic.)

The present author found a complete reproduction of Aubrey's *Memoirs of Dr. Harvey* in the *Eclectic Repertory and Analytical Review*, Medical and Philosophical, VI, 1816, pp. 107-113 inclusive. The editors of the *Eclectic Repertory* had in turn taken it from *The London Medical and Physical Journal*. Neither periodical credits it to Aubrey who according to Leake¹ was Harvey's first biographer.

Many biographers of Harvey quote snatches of Aubrey usually without crediting the author.

The ensuing reproduction was made from the *Eclectic Repertory* which was compared carefully with the original Aubrey letters as noted above, Vol. II, Part II, London 1813, pp. 376-386. This transcription from the *Repertory* is exact in wording but not in spelling, italicization, and punctuation except that the *Repertory* omitted the passage in brackets [] which I have copied from Aubrey and which I have never seen reproduced.

It should be borne in mind that the following account of Harvey by Aubrey is authentic since Aubrey knew Harvey, in fact was one of the great physician's pallbearers as he plainly states in the text which follows herewith—

MEMOIRS OF THE CELEBRATED DR HARVEY

From Votes Collected from the Bodleian Library and Ashmolean Museum

(Lectures written by Emberton Parsons in the 7th and 8th centuries; 1 which are added, *Historia* Journeys to Reading, and to Whaddon Hall, The Seat of Inverness, Ely, and Lives of Emberton Men, by John Aubrey, etc. — The whole was first published from the Originals in The Bodleian Library and Ashmolean Museum, with Biographical and Literary Illustrations — in two volumes, Vol. 1, London. Printed for Longman, Hurst, Rees, Orme, and Brown, Paternoster Row and Moxley and Miller Oxford. &c.)

GUL. HARVEUS Aet. 10, in Schola Cantuar. primis doctrinae rudimenta imbutus 14. Col. Gouvil. et Coll. Alumnus 19, peragravit Galliam et Italiam 23 Privatim Praeceptores habuit East. Radium, Tho. Minad H. Fab ab Aquapend. Consul Angl. 16 6t 24, Doctor Med. et Chirurg. Reverens Lond. praxin exercuit, et uxorem^m duxit 25 Coll. Med. Socius 37 Anatom. et Chirurg. Professor 54 Medicus Regius lactus. Scriptis de Motu Sanguinis, et de Gen. Animal. Obiit 30 Jan. MD CLVII. Aet. 80# (But I well remember that Dr. Alsop at his funeral said, that he was eighty wanting one and that he was the eldest of nine brethren.)

He lies buried in a vault at Hempstead in Essex, with his brother Eliah Harvey built, he is laid in lead, and on his breast in great letters Dr William Harvey. I was at his funeral, and helpt to carry him into the vault.

In the library at the Physicians College was the following inscription above his statue, (which was in his doctoral robes)

Gal. Harveys, Natus A D 1578 Apr 2 Folk
ston, f in Corn. Cantil, Primogenitus Tho Harvet
et Joanae Hall. Frat. Germani Tho Jo. Dan
Eliab Mich. Mat. Sorores Sarah Amey

Under his white marble statue, on the pedestal,

GULIELMO HARVEO
Vivo
Monumentis suis immortalis
Hoc insuper
Coll. Med. Lond.
Posuit
Qui enim Sanguinis Motum
(ut et animal ortum) dedit
meruit esse
Stator Perpetuus.

THE EDITOR

Over Dr. Harvey's picture, the great picture under the library at the Massachusetts College at Amherst (Amherst).

Dr Harvey added (or was very beautiful in contributing to) a noble building of Roman architecture (of rustic work with Corinthian pillars) at the Physicists College aforesaid, viz. a great parlour a kind of convocation-house for the fellows to meet in below and a library above. On the outside on the freeze in letters three inches long, is this inscription, SUASU ET CURA FRAN. PRUTEANT. PRAESIDIS ET EDMUNDI SMITH ELECT. INCHOATA ET PERFECTA EST HAEC FABRICA AN. MDCLXIII.

All these buildings and remembrances were destroyed by the general fire.

He was always very contemplative, and the first yt. I heard of yt. was curious in Anatomie in England. He had made dissections of frogs, toads, and a number of other animals, and had curious observations on them. which papers, together with his goods, in his lodgings at White hall, were plundered at the beginning of the rebellion, he being for the king and with him at Otton. but he often sayd, that of all the losses he sustained no griefe was so crucifying to him as the losse of these papers, which for love or money he could never retrieve or obtaine. When K. Ch. I. by reason of the tumults left Lond, he attended him and was at the fight of Edge-hill with him, and during the fight, the Prince and D. of York were committed to his care. He told me that he withdrew with them under a hedge, and tooke out of his pocket a booke and read, but he had not read very long before a bullet of a great gun grazed on the ground neare him, which made him remove his station. he told me yt. Sir Adrian Scrope was dangerously wounded there, and left for dead amongst the dead men, stript, which happened to be the saving of his life. It was cold clear weather and a frost that night, which stauched his bleeding, and about midnight, or some hours after his hurt, he awaked, and was faine to drawe a dead body upon him for warmth sake.

After Oxford was surrendered, which was 24 July 1646, he came to London, and lived with his brother Eliah, rich merchant in London, on _____ hill, opposite to St Lawrence, Poeltry

There is the house which, near the post house, has seven brick houses, which he gave to Cecil and to Constance, with some lands there, and yet the brother Jack would have given me money or exchange for it, because 'twas his father's and they all hated there, but the doctor (truly) thought his money worth it. He never possessed this way for his brother has left noble sons, and about four pounds per annum at least.

where was then a high leaden steeple, (there were but two, viz this and St Dunstan's in the east,) and at his brother's country house at Roehampton His brother Eliab bought, about 1654, Cockayne-house, now (1680) the Excise Office, a noble house, and had his severall stations, in regard of the sun, or wind He did delight to be in the darke, and told me he could then best contemplate

He had a house heretofore at Combe, in Surrey, a good air and prospect, where he had caves made in the earth, in which in the summer time he delighted to meditate He was pretty well versed in mathematiques, and had made himselfe master of Mr Oughtred's Clavis Math in his old age, and I have seen him perusing it, and working problems not long before he dyed, and that book was always in his meditating apartment His chamber was that room which is now the office of Elias Ashmole, esq where he dyed, being taken with the dead palsey, which took away his speech, as soon as he was attacked, he presently sent for his brother and nephews, and gave one a watch, another another thing, &c as remembrances of him He dyed worth 20,000 pounds, wch he left to his brother Eliab In his will, he left his old friend, Mr Tho Hobbes, 10 pounds, as a token of his love

He was wont to say, that man was but a great mischievous baboon

He would say, that the Europeans knew not how to order or govern our woemen, and that the Turks were the only people (who) used them wisely

He had been physitian to the Lord Ch Bacon, whom he esteemed much for his witt and style, but would not allow him to be a great philosopher, Said he to me, "He writes philosophy like a Ld Chancellor," speaking derision *

About 1649, he travelled again into Italy, Dr George, now Sir George Ent, then accompanying him

At Oxford he grew acquainted with Dr Charles Scarborough, then a young physitian, (since by Ch II knighted) in whose conversation he much delighted, and whereas before, he marched up and downe with the army, he took him to him and made him ly in his chamber, and said to him, "Prthee leave off thy gunning, and stay here, I will bring thee into practice" ["I remember he kept a pretty young wench to wayte on him

wch I guesse he made use of for warmth's sake, and tooke care of her in his will, as also of his man servant"] (This passage occurs in Aubrey's account and is the only passage omitted in the reprint which does not even credit Aubrey with having written the entire biography The account appears in vol II, Part II, p 381 of Aubrey's book) For twenty years before he dyed, he took no manner of care about his worldly concerns, but his brother Eliab, who was a very wise and prudent manager, ordered all not only faithfully, but better than he could have done for himselfe He was, as all the rest of the brothers, very cholerique, and in his younger days wore a dagger (as the fashion then was, nay I remember my old school-master, Mr Latimer, at seventy, wore a dudgeon, with a knife and bodkin, as also my old grandfather, Lyte, and alderman Whitson, of Bristowe, wch I suppose was the common fashion in their young dayes,) but this Dr would be apt to drawe out his dagger upon every slight occasion

He was not tall, but of the lowest stature, round faced, olivaster (like waunscott) complexion, little eie, round, very black full of spirit, his haire was black as a raven, but quite white twenty years before he dyed

I first sawe him at Oxford, 1642, after Edgehill fight, but was then too young to acquainted with so great a doctor I remember he came severall times to our Coll (Trin) to George Bathurst, B D who had a hen to hatch egges in his chamber, which they dayly opened to see the progress and way of generation I had not the honour to be acquainted (with) him till 1651, being my cos Montague's physitian and friend I was at that time bound for Italy, (but to my great grief dissuaded by my mother's importunity) He was very communicative and willing to instruct any that were modest and respectfull to him And in order to my journey, dictated to me what to see, what company to keep, what bookes to read, how to manage my studyes, in short, he bid me go to the fountaine head, and read Aristotle, Cicero, Avicenna, and did call the neoteriques s t breeches He wrote a very bad hand, which with use I could pretty well read I have heard him say, that after his booke of the Circulation of the Blood came out, he fell mightily in his practice, and 'twas believed by the vulgar, that he was crack-brained, and all the physitians were against his opinion, and envyed him, with much adoe at last in about twenty or thirty yeares time, it was received in all the universities in the world, and, as Mr Hobbes says in his book, "De Corpore," *he is the only man, perhaps, that ever lived to see his owne doctrine established in his life-time*

*This must relate to Bacon's physiological opinions as exemplified in his *Historia Vitae & Mortis* the work which produced so much wit in the Tristram Shandy concerning radical heat and radical moisture Harvey's mode of inquiry was exactly such as Bacon pointed out in his *Nov Organum* But it must be admitted that Bacon's only physiological work savours much of precedents in the Lord Chancellor style.—Edit.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE recent volume of 257 pages by Jean Oliver entitled *Architecture of the Kidney in Chronic Bright's Disease*¹ is beautifully printed and illustrated on a semi gloss paper. The work is well seasoned because of the author's long collaboration with the renal student, Dr. Thomas Addis. The first plate is a microdissection of a lobule of the normal adult kidney and the next 8 pages are given to a discussion of the methods and technique used in preparing the material.

The following chapter presents new and detailed measurements of the unit of renal function which show that proximal tubule "hypertrophy" may result in doubling the length of this portion and increasing its volume by 5, so that a single hypertrophied proximal tubule may "equal in size or, in the diseased organ, take the place of ten normal units." Atrophy of the rest of the unit is variable. Capacity of function may be compared with this combined atrophy and hypertrophy. However, evidence is presented which shows that in terminal Bright's disease the blood supply is shunted around the glomerulus to the constantly developing proximal convoluted tubules, and that these tubules have the ability "to take over the function of the destroyed glomeruli." With regard to these proximal tubules "even when they themselves are at last disrupted, their remaining portions persist and maintain structural characteristics that present evidence of progressive growth and active vitality." Further work is needed to evaluate these important observations. The suggested specific function of various parts of the tubule indicated by Dr. Oliver's work should offer a fertile field because of the increasing clinical evidence of specific mineral metabolic factors which so greatly alter the clinical and therapeutic problems met by the physician. The author's dissections and models demonstrate the difficulty and often misleading appearance of the end-stage cystic tubule residuals brought about by scar tissue and collagenous material when studied by the ordinary microscopic section.

This volume stands not only as a compliment to Dr. Oliver but is a tribute also to patience and to research by new methods into the field of pathological physiology which are so urgently needed.

M. HERBERT BARKER

THE author has correlated an enormous mass of material in *Operative Orthopedics*² that would require a great deal of time and effort on the part of

¹ ARCHITECTURE OF THE KIDNEY IN CHRONIC BRIGHT'S DISEASE. By Jean Oliver. New York and London: Paul B. Hoeber, Inc. 1939.
² OPERATIVE ORTHOPEDICS. By Willis C. Campbell, M.D. St. Louis: The C. V. Mosby Co. 1939.

the individual doctor. Campbell has shown conservatism and mature judgment, he knows what to expect from non-operative treatment and appreciates the virtues and limitations of conservative care. The selection of material, its assembly, and composition are highly recommended.

He discusses the physiology and pathological changes that occur in bones and joints and their related structures. His chapters on surgical technique and surgical approaches are among the highlights of the book, his discussions of pyogenic and arthritic infections and osteomyelitis are well done.

The sections on congenital anomalies, static and postural defects, neurological affections, and disturbances of muscles, tendons, and bursae are well worth reading. There is also a section on arthrodesing operations.

I have, however, left 3 of the outstanding sections for the last, viz., arthroplasty, traumatic conditions, and tumors. The author is a pioneer in the subject of arthroplasty and much of his work is standard. His contributions to the subjects of internal fixation, the treatment of malunion and non-union of fractures are generally accepted. Campbell's relatively vast experience in bone tumors makes his contribution worthy of serious consideration. He has always co-operated with the Bone Tumor Registry of the American College of Surgeons.

The cost of the book is more than balanced by its value. It marks a real advance. The author accomplished what he started out to do. It is a big job well done, and could be accomplished only with a full time staff such as Campbell has, including Speed, Boyd, and Smith medically and Ingram and Summers artistically.

The publishers of books of this type should be encouraged.

PHILIP LEWIN

IN a 236 page monograph entitled *Peripheral Vascular Diseases*,³ Collens and Wilensky cover briefly the present day knowledge of the signs and symptoms and the treatment of the commoner peripheral arterial disturbances as arteriosclerosis, thromboangitis obliterans, and Raynaud's syndrome. It is a well written book as far as it goes, but unfortunately the authors mention the less common peripheral arterial disturbances only very briefly, and such important subjects as arterial aneurisms and arteriovenous fistulas are not discussed. The venous and lymphatic disturbances of the extremities are not mentioned.

³ PERIPHERAL VASCULAR DISEASES, DIAGNOSIS AND TREATMENT. By William S. Collens, B.S., M.D. and Nathan D. Wilensky, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1939.

The book is divided into parts anatomy and physiology. Diagnosis is discussed in the first part and treatment in the second part of the book. The various diagnostic signs and symptoms are described very clearly, but the physiological interpretation of some of the diagnostic tests is not discussed adequately. All the known therapeutic measures used for peripheral arterial disturbances are described. The book is easy to read and should be a help to those unacquainted with peripheral arterial disturbances.

SAMUEL FLEISS

THE sixth edition of Palmer J. Flagg's *Art of Anesthesia* is a 480 page amply illustrated, well bound volume. The book has been changed from its previous editions in many ways. Chapters devoted to cyclopropane and the carbon dioxide technique and discussions including divinyl ether helium and the art of laryngoscopy and intubation help to bring the volume up to date.

The author presents fairly comprehensive survey of the subject and includes the classification, characteristic signs, and technique of administration of the various commonly used and newer anesthetic agents. Subjects which are intimately associated with or which may be considered a part of anesthesiology, such as oxygen therapy or the physiological and theoretical basis of anesthesia, are not discussed.

There are discrepancies in the paging of the index tabulation, and references to various pages in the book are incorrect. Apparently these have not been changed from the previous edition.

It is noted that though much of the material is elementary there is practical aspect to the book which only a man who has given many years to the specialty could convey.

MARY KARR

THE grouping of all sclerosing therapy in one volume is a good idea, for in a sense it is all similar and this new book, *Sclerosing Therapy*, fills real place on the shelf of any physician who is at all interested in the treatment of these conditions.

The section on the injection treatment of hemoids is by far the best and most thorough part of the work. Dr. Bratrud has covered it well and in detail, and yet it is not too verbose. The anatomical drawings and charts show the anatomy so clearly that any study any physician should clearly understand just what the author is trying to do. This together with the chapter on technique makes the work appear very simple indeed. He believes the proper fitting and bearing of the truss is the most important single point in the successful treatment of hernia. The pathological studies are very thorough and clearly show the results of the injections, which seem to be conclusive of the good results to be obtained. The subject of solutions used is all covered and

the author leaves no doubt as to just what he thinks about each solution. He clearly states that he prefers the proflavine T special for the usual case.

The chapter on the injection treatment of hydrocele is concise and yet the subject is well covered. Dr. Hock has made it simple but has emphasized the important points of care and attention to details. He prefers the use of guaiac preparations for this work. However he did not sufficiently emphasize the importance of the tight, all elastic suspensory for the first few days immediately following the treatment.

Part 3 is devoted to the treatment of varicose veins. The same space is given this subject as is allotted the treatment of hernia. The subject is well covered and takes up all phases. Dr. Shelby has made a most thorough review of the literature and has followed a happy middle ground throughout the work. He is conservative and yet thorough. The chapter on preliminary ligation is good, the drawings are above the average, and his reference index is very complete.

There are 50 pages on the injection treatment of hemorrhoids. The author makes a plea for the injection of only internal uncomplicated hemorrhoids. The anatomy and embryology are briefly but adequately outlined. These must be understood before injection therapy is used. The author states that 50 per cent of cases seen represent uncomplicated internal hemorrhoids which are suitable for either injection or surgery. This figure is high for those cases which are suitable for injection alone.

Solutions containing proflavine are preferred and of course only internal hemorrhoids can be injected. The exact technique, solutions used and recommended are discussed. Recurrences are more common after injection than following surgery.

The subject is well outlined and covered and any one interested in the injection treatment of hemorrhoids cannot but be aided by reading and studying this article.

H. O. McFARLAND

THE collection of lectures by Leriche, entitled *The Surgery of Pain* is an exposition of the author's conception of pain gathered from the study of pain in the clinic, that is, "living pain." But little attempt is made to explain the physiology of pain by experiment or accepted theories, and the author seldom feels called upon to justify his ideas in the light of such theories. Actually the book is somewhat of an idle fiction, since it deals principally with the surgery of the sympathetic nervous system and the clinical relationship of these nerves to pain, which has long been a professional lore of the author.

As pointed out by the translator many of the views set forth are revolutionary, many are entirely unaccepted by today's physiologists. But after reading the book, one cannot but be impressed by its frankness by the author's honesty and sincerity.

THE SURGERY OF PAIN by René Leriche, M.D. (Lyon), LL.D. (Chicago). R.C.S. (Eng.). Translated and edited by Arthur (Giles) B. Scott, M.B., Ch.B., F.R.C.S. (Edin.). (Scotlands) Baltimore: The Williams & Wilkins Co. 1929.

THE ART OF ANESTHESIA. By Palmer J. Flagg, M.D. 6th rev. ed. Philadelphia, London, Montreal: J. B. Lippincott Co., 1928.

SCLEROSING THERAPY FOR THE INJECTION TREATMENT OF HEMORRHOIDS, VARICOSE VEINS, AND HYDROCELES. Edited by Frank C. Yarnall, M.D. F.A.C.S. M.R.S.M. (London, then) Baltimore: The Williams & Wilkins Co. 1929.

and by his ready admission of certain failures. Agreeing or not with the many bold statements, the reader must admit that the book is provocative of thought, that its logic is generally good, and that there must be some merit in the methods which have produced favorable results in such a large number of patients. The style is free, informal, almost conversational at times, aphorisms are to be found, and, unfortunately, the author in places becomes platitudinous. For a translated work, it seems apparent that the original style has been unusually well preserved and brought over into English.

The book is over 500 pages long and deals with practically every sort of pain. Facial neuralgia, causalgia, the pains of amputation stumps, nerve injuries, and various vasoconstrictive diseases, the pain of angina pectoris, and several other pain entities are considered. Most of these subjects are covered with a discussion of existing theories as to cause, the experimental data at hand (which is often incomplete) the rôle of the sympathetic nervous system, the operative attack, and a minimum of illustrative case reports. To Leriche there are 2 general kinds of pain: the pain of the cerebrospinal type, fixed, localized, and anatomical in limit, and the pain of the sympathetic type, diffuse, spreading, vague, and closely related to emotional states. A purely sympathetic pain may be controlled by the proper measures aimed directly at the sympathetics, also, the cerebrospinal type of pain may in many instances be cured or alleviated by novocainization or ablation of the appropriate sympathetic ganglion.

The chapter on trigeminal neuralgia is particularly stimulating. Leriche defies anyone to show that arteriosclerosis, hypertension, diabetes, arterial compression of the root (Dandy), or other simple mechanical devices are the actual causes of this pain syndrome. His experiences with it have been much the same as those of other large clinics. Like most investigators, he is at a loss to name its cause, like most neurological surgeons he prefers to section the root by way of a subtemporal approach, and, as many others, he sees postoperative facial weakness, keratitis, and facial vesicular eruptions in some of his patients.

Leriche is very definite in the application of his beliefs regarding visceral pain to the surgical treatment thereof. He believes visceral pain to be an actual fact. He is impressed by the individual data furnished by François Franck, Kiss, and Collin, and he frankly disbelieves the theories explanatory of referred pain propounded by Mackenzie. He has treated 27 cases of angina pectoris surgically with generally satisfactory results. His aim is (1) to interrupt the initial vasoconstrictor reflex, (2) to establish a regimen of coronary vasodilatation, and (3) to reduce cardiac activity. To do this he excises

or infiltrates with novocain the left stellate ganglion, a procedure which he holds to be anatomically correct.

The uses of periarterial sympathectomy, ganglion excision, ganglion novocainization, presacral neurectomy, etc., if not entirely original with Leriche, certainly find in him a leading exponent. The investigation of pain has been to him a hobby. Discontent with the use of "makeshifts" in the treatment of pain, he is sincerely satisfied with the effectiveness of his sympathetic surgery, though he admits it is no panacea, and he will remain firm in his trust in it as long as his clinical results justify such a stand, in spite of the thunder of all the physiologists in disagreement.

JOHN MARTIN

DR HAUSER'S *Diseases of the Foot*¹ is not a book on acquired deformities and strains of the foot, but is a broad treatise of 472 pages which attempts to cover most of the known conditions which affect human feet. There is a short description of the anatomy and physiology of the foot, followed by chapters on shoes, hygiene, and general care of the feet with instructions for correct walking and standing. This is followed by a chapter on various types of flat feet with the treatment which the author recommends and includes the types of arch supports which he prefers. This is followed by acquired and congenital deformities of the toes with descriptions of the surgical operations which are usually used to correct them. There is a good chapter on accessory tarsal bones and another on circulatory disturbances of the foot and ankle.

Included in the book are chapters of various sprains of the foot and ankle, on fractures and dislocations of various bones of the foot and ankle, and on diseases of the nerves of the foot. The book also includes a chapter on the usual deformities of the foot which occur as a result of poliomyelitis and on congenital club foot. The various skin diseases which may affect the foot are also described and the accepted form of treatment for each is recommended.

Finally, there is a section which deals with the changes in the foot due to chronic arthritis.

On the whole, this is a book which will appeal to the man in general practice rather than to the specialist, because it covers such a wide field that no single subject can be treated exhaustively. However, I think that it fills a definite need and is a book which can be recommended to those who wish information on diseases, injuries, or deformities of the foot. Its value is accentuated by references to the literature which are placed at the end of each of the 30 chapters.

J ALBERT KEY

¹ DISEASES OF THE FOOT. By Emil D. W. Hauser, M.S., M.D. With a foreword by Sumner L. Koch, M.D. Philadelphia and London: W. B. Saunders Co. 1939.

BOOKS RECEIVED

Books received are acknowledged in this department, and each acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

ORTHOPEDIC OPERATIONS; IDEAS, FACTS, TECHNIQUE, AND EA. RESULTS By Arthur Steindler M.D. F.A.C.S. Springfield, Ill., Baltimore, Md. Charles C. Thomas, 1940.

ATLAS OF CARDIOLOGY: CLINICAL METHODS AND CASE HISTORIES AS PROBLEMS FOR STUDY By William Duncan Reid, A.B. M.D., F.A.C.P. London, New York, and Toronto: Oxford University Press, 1940.

REPORTS OF MEDICAL PROGRESS, 1939 AS PUBLISHED IN THE NEW ENGLAND JOURNAL OF MEDICINE Compiled and Edited by Robert N. Nye, M.D. Boston. Little, Brown & Co., 1940.

HEIL, HITLER! HEIL! UNDER HITLER By Dr. Martin Gumpert. Translated from the German by

Marjorie Samuel. New York and Toronto: Aldine Book Corp., Longmans, Green & Co., 1940.

ATLAS OF SURGICAL ORTHOPEDICS By Elliott C. Carter and Robert Zollinger. Illustrated by Alfred B. Coddag. New York: The Macmillan Co., 1940.

FRONTIER OF THE SKULL, BRAIN AND SPINAL CORD: NEURO-PATHOLOGY, SURGERY, AND MEDICO-LEGAL ASPECTS Edited by Samuel Brock. A. Williams Wood Book, Baltimore. The Williams & Wilkins Co., 1940.

SWITCH, BLOOD STUDIES AS A GUIDE TO THERAPY By John Scudder M.D. Med.Sc.D. F.A.C.S. Philadelphia, Montreal, London. J. B. Lippincott Co., 1940.

THE MANAGEMENT OF OBSTETRIC DIFFICULTIES By Paul Tarns, M.D. 2d ed. St. Louis: The C.V. Mosby Co., 1940.

A TEXTBOOK OF SURGERY By John H. Moore, M.D. 5th ed. Springfield, Ill., and Baltimore, Md. Charles C. Thomas, 1940.

CORRESPONDENCE

RE-ESTABLISHMENT OF GASTRO-
INTESTINAL PASSAGE AFTER
GASTRIC RESECTION

To the Editor

In the issue of SURGERY GYNECOLOGY AND OBSTETRICS for February 5, 1940, in an excellent article by Professor Pálva entitled "Re-Establishment of the Gastro-Intestinal Passage after Gastric Resection," a misstatement appears which it might be well to correct in order to keep the record straight.

On page 7 Professor Pálva is good enough to mention the operation that I have been doing for

partial gastrectomy. The drawing of Figure 4 is not clear but in the text it says "d, anterior end-to-side duodenogastrostomy—modification of the former operation—implantation of the duodenal stump into the anterior wall of the stomach. As a matter of fact this partial gastrectomy to which he refers is an end-to-end union of the duodenum, after flaring it open, to the stump of the stomach, preserving the relationship of the lesser curvature of the stomach to the upper border of the duodenum.

Anatomically I would think it would be impossible to implant the duodenal stump into the anterior wall of the stomach.

J. SARRIS HONOLULU

SURGERY

GYNECOLOGY AND OBSTETRICS

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CONTROLLED FLUID THERAPY

With Hematocrit, Specific Gravity, and Plasma Protein Determinations

CHARLES R. DREW, M.D., C.M., JOHN SCUDDER, M.D., F.A.C.S., and
JEAN PAPPS, M.D., New York, New York

WITH the increasing consciousness of the importance of fluids has come an increasing demand for more rapid, accurate, objective methods of determining the fluid requirements of acutely ill patients and for maintaining water balance when once established.

We have found that 4 relatively simple tests give much useful information concerning the state of hydration in seriously ill surgical patients (26). These are (1) Determination of the percentage of cells in venous blood by means of a hematocrit, (2) determination of the specific gravity of the whole blood, (3) determination of the specific gravity of the plasma, and (4) calculation of the plasma protein content by means of a simple formula. The merit of these combined tests lies in the speed with which they can be done, the accuracy with which results can be reproduced, the small amount of equipment necessary, and the ease with which the technique may be mastered.

The danger lies in attempting to interpret these findings without a clear clinical picture of the patient. This approach to a difficult problem is presented as an aid to, not as a

From the Department of Surgical Pathology of Columbia University College of Physicians and Surgeons and the Department of Surgery of the Presbyterian Hospital.

substitute for, already well established, diagnostic procedures.

The opinions expressed here have grown out of 3 years' experience. Because of the numerous requests as to both methods and interpretation (27, 28), each of the tests will be considered separately in some detail.

THE HEMATOCRIT

In 1885, Professor Blom presented at Upsala the first "haematokrit." It was modeled after the "laktokrit" used in the dairy industry. Employing this method, Hedin, in 1891, reported an average cell volume for adult males to be 48.0 per cent, and for adult females, 43.3 per cent. In the next 10 years there were many modifications. Capps, in 1903, introduced this work to America.

Haden (11), in 1923, popularized the large hematocrit tube in contradistinction to the capillary type and stressed the importance of using isotonic solutions of the various anticoagulants. Van Allen, in 1925, published a comprehensive résumé on the hematocrit method in experimental work. Wintrobe and Miller then introduced a 4 cubic centimeter graduate tube, made from a Mohr pipette, they employed potassium oxalate as the anticoagulant and allowed 6.7 per cent for cell

shrinkage. The publication of Haden (12) in 1930 is very complete and for further details this article is recommended.

In 1929, Sanford and Magath modified the Haden hematocrit. It is this tube which we prefer because it can be spun in any routine laboratory centrifuge, can be cleaned easily, and being made of heavy glass, its durability is enhanced.

Anticoagulant. Heparin is the anticoagulant recommended for hematocrit determinations (8). It is an active fraction of the naturally occurring anticoagulant which was first isolated in Howell's laboratory by McLean in 1916. The heparin now employed is the sodium salt as prepared in the Connaught Laboratories of Toronto University, Canada. One milligram of the powder is sufficient anticoagulant for the blood in a Sanford Magath hematocrit tube.

Directions for taking blood and reading the hematocrit. Draw blood from vein with sterile dry syringe without the use of a tourniquet if possible, or if a tourniquet is used, release it and wait a minute for blood to recirculate before drawing the sample.

Gently introduce from 5 to 6 cubic centimeters into Sanford-Magath hematocrit tube containing the proper amount of heparin. Avoid air bubbles.

3. Gently invert the tube two or three times to mix the blood with the anticoagulant.

4. Cork with rubber stopper (No. 41 No. 5) counter balance and spin centrifuge for hour at 500 revolutions per minute (In emergency cases 5 minutes is sufficient).

5. Record the level of cells and the level of total blood sample.

6. To determine cell volume divide the cells by the total volume. In normal blood the white cells form just a thin layer on top of the red cells, and it is not worthwhile to attempt differentiation. In severe infections however usually associated with some degree of anemia it is worthwhile to measure the cell volume of the erythrocytes and leukocytes separately by dividing the volumes of each by the total blood volume in the sample.

7. Hemolysis in the plasma is most often caused by the use of a wet syringe and less often by too vigorous shaking. The presence of thin filament extending from bottom of the meniscus to top of the cells indicates fibrinogen-fibrin mixture due either to insufficient anticoagulant or incomplete mixing. It decreases the cell volume somewhat and the plasma specific gravity determinations, but neither is significant for clinical purposes.

Normal values (Fig. 1). The normal cell volume values for the male range between 42

and 50 per cent, the average being approximately 46 while those for a female have a range of 39 to 43 per cent, with an average of 41.

SPECIFIC GRAVITY

The earliest investigator of blood specific gravity was Robert Boyle who, in 1684, showed that both serum and whole blood were heavier than water. Jarin, in 1719, measured their weights more accurately and reported the specific gravity of the blood as 1.053 and that of the serum as 1.030. Sir John Davy in 1839, determined by pycnometry the specific gravity of the whole blood and quoted freely from the earlier work of John Hunter who showed that specific gravity was high in the morning, high in inflammation, and high in dehydration.

Roy in 1884 reported a simplified method of weighing blood. E. Lloyd Jones (16, 17) in 1887 and later in 1891 used this method and published observations which are still of outstanding value for specific gravity determinations in both health and disease.

Hammerschlag compiled a very complete summary and introduced the use of benzol and chloroform as a modification of the Roy method. Sherrington and Copeman observed that a fall in blood pressure during a long experiment or operation was accompanied by a fall in specific gravity of venous blood. Hemorrhage was followed by a rapid fall while vasoconstriction as seen in shock caused an early rise in the specific gravity of peripheral blood. Rogers showed the value of these tests in treating the severe dehydration of cholera.

In 1924 Barbour and Hamilton (2, 3, 4) presented a means for determining the specific gravity of body fluids which eliminated many disadvantages of the older methods (Fig. 2). The principle based on Stokes' law takes advantage of the fact that the time required for a drop of known volume to fall a fixed distance through an immiscible fluid is governed by the density of the drop and other factors, such as temperature, which can be controlled easily. It has been shown that differences of 0.2 of 1 per cent in weight are demonstrable and that specific gravities may be reproduced with an accuracy of 0.0001.

DREW, SCUDDER, PAPPS CONTROLLED FLUID THERAPY

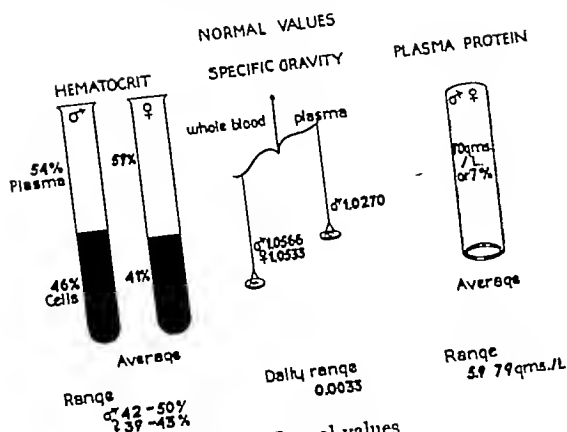


Fig 1 Normal values

Stebbins and Leake, in 1927, and later Polowe, and Bender and Polowe employed this method for clinical purposes Guthrie, in 1932, reported that when compared with other methods for evaluation of blood conditions it stood first from every standpoint For those unacquainted with the values of whole blood specific gravity, he offered the following simplified comparative table of approximate values

Specific gravity	Hemoglobin	Hematocrit per cent cells	Red blood count
1.030	0	0	0
1.035	20	10	1 000 000
1.040	40	20	2 000 000
1.045	60	30	3 000 000
1.050	80	40	4 000 000
1.055	100	50	5 000 000
1.060	120	60	6 000 000

It is a modification of the Barbour and Hamilton apparatus¹ which we use routinely in the determination of whole blood, serum, and plasma specific gravity

Normal values In the male the average value of peripheral blood is 1.0566 and in the female 1.0533 A swing of 0.0033 occurs daily, the blood is more concentrated in the morning

Practical directions for determination of the specific gravity of whole blood (Fig 3) 1 Observe and record temperature of water bath in which the falling drop tubes are immersed

¹Complete sets may be obtained from Elmer and Amend New York City or LaMotte Chemical Company Baltimore Maryland

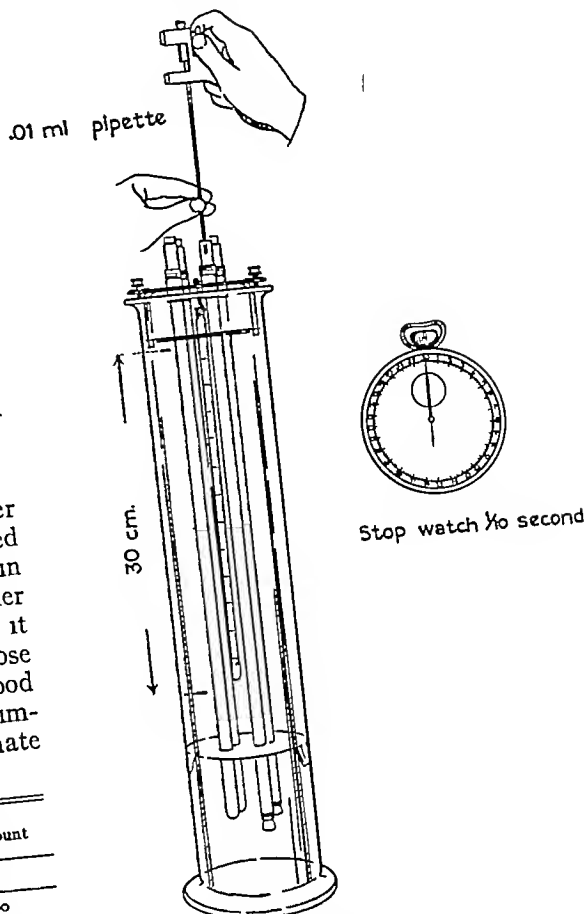


Fig 2 Modified Barbour and Hamilton falling drop apparatus with Guthrie pipette holder From the graduated pipette 0.01 ml of plasma is released into a tube containing a mixture of bromobenzene and xylene and timed with a stop watch in its course between the two marks on the tube. The same process is carried out with a solution of known specific gravity and the weight of the unknown calculated (4)

- 2 Set stop watch at zero time.
- 3 Remove cork from the bromobenzene tube to be used
 B₁ for normal and concentrated bloods (6)
 Specific gravity 1.0530
 B₂ for anemic bloods
 Specific gravity 1.0430
- 4 Load pipette into holder
- 5 Puncture finger, wipe away first drop, draw up blood into the calibrated pipette from a free bleeding, puncture wound to the second mark. (The pipette is made to deliver 2 drops of 0.1 milliliter each)
- 6 Quickly (for no anticoagulant is used with whole blood) wipe the outside of the pipette with gauze, bring the drop of blood even with the middle

Room
Temperature $^{\circ}\text{C}$

Falling Time

Apparent Density Difference Between Drop and I.D.D.

Fig. 3. Nomogram. Directions: (1) Insert pipette thread attached on the "temperature scale" to the recorded temperature of the test bath; (2) draw thread across the "falling time" scale to the correct time in seconds that it took the plasma to fall 30 centimeters; (3) read off the figure which the thread bisects on the "apparent density difference"

scale. (This gives the difference in density between the xylene bromobenzene mixture and the plasma); (4) repeat same steps for the standard; (5) calculate specific gravity as directed. (Courtesy of H. G. Barbour, J. Am. Med. Ass., 9:27 83-9-34)

mark on the pipette, insert the tip of the pipette just below the surface of the bromobenzene xylene mixture, with care not to touch the sides of the tube now turn the thumb screw on the pipette holder until the blood is at the level of the next mark, then gently lift the pipette out of the tube, and release the drop of blood. The surface tension existing between the blood and the mixture in the tube causes its release.

7. Time the fall of the drop of blood by pressing the top watch as the center of the drop passes the upper mark and again as it passes the lower mark, 3 centimeters below on the tube, and record the falling time.

8. Repeat the procedure using another finger if the blood is not flowing freely from the first puncture, and clean pipette. Two drops of whole blood should not be dropped from the same pipette, for the second drop is always heavier as the result of sedimentation of the cells in the interval during which the first drop is falling. Pipettes should be rinsed with ammonia water immediately after they have been used for whole blood specific gravity, then washed with ether alcohol, and ether. Record the time.

Cleanliness of these capillary tubes is the greatest limiting factor for securing accurate results. Redistilled acetone can be employed to advantage in carrying out this technique.

9. In a similar manner draw up the standard just above the upper mark on the pipette, draw it down even to the mark by touching the tip to piece of gauze, then determine its falling time between the marks on the tube.

Criteria for checks on fall time. When drop of blood, plasma, serum, or standard potassium sulphate solution falls in the bromobenzene mixture, successive drops from the same or different pipettes should give apparent density differences of not greater than \times . It will be observed (Fig. 3) that 0.1 of second in the rapid range of falling time constitutes larger range in the apparent density differences than 5 of second difference in the falling time of successive drops at the other end of the scale. When accurate checks can not be made, sufficient number of drops should be done to establish good average falling time.

Reasons for inability to get checks on drops. (1) Dirty pipettes cause drops of varying sizes to be delivered. (2) Slipping drop due to rubber tubing in pipette holder being too large causing incomplete suction. (3) Too much tension on thumb screw at moment of release causes rebound of fluid in pipette when drop is released. Thumb screw should compress rubber tubing in holder uniformly and should be released before pipette is removed from tube so that level of fluid in pipette remains at the mark. (4) Twisting of hand tending tip of pipette increases

The standards should be preserved under oil, small portions being removed for daily work.

pressure in rubber tube and, therefore, a rebound suction action occurs at release. Relieve all tension before drop is released. (5) Currents in the dropping tube due to rapidly changing temperature on one side of the water jacket, e.g., that caused by opening a window or lighting a burner near the apparatus. (6) Air bubble or particle of solid material. (7) Poor reaction time in using stop watch. A stop watch stand¹ will aid in accurate timing. (8) Incomplete mixture of the bromobenzene xylene solution causing varying rates of speed in the falling drop. (9) Gross differences in temperature between bromobenzene mixture and plasma. These are minor technical details which are quickly mastered but which in the beginning give trouble.

Determination of the specific gravity. 1. To calculate the apparent density difference between the blood and the mixture through which it falls, insert a pin on the temperature scale (Fig. 3) at the temperature of the water bath and with a thread cross the "falling time" scale at the figure given by the stop watch. The thread will cross the "apparent density difference" line at a point which gives the difference in density.

2. Calculate the apparent density difference between the standard and the bromobenzene xylene mixture in a similar manner.

3. Calculate the true density difference between the blood and the standard by subtracting the lesser figure from the greater.

4. Correct for temperature by subtracting from the specific gravity of the standard 0.0001 for each 2 degrees' change in temperature above 20 degrees C and by adding 0.0001 for every 2 degrees below 20 degrees C.

5. If the blood falls faster than the standard, it is heavier, therefore, the true density difference is added to the corrected specific gravity of the standard. If the blood falls slower than the standard, it is lighter, therefore, the true density difference is subtracted.

Example

Specific gravity of standard	1.0550	
Correction for temperature of 22° C	-0.0001	
Corrected specific gravity of standard		1.0549
Falling time of blood	21.5 secs	
Apparent density difference	0.0115	
Falling time of standard	27.5 secs	
Apparent density difference	0.0086	
True density difference		
	0.0115 - 0.0086	0.0029
Specific gravity of blood		1.0578

This whole procedure can be carried out in about 2 minutes. This cannot be used to determine proteins. While the proteins do contribute to the specific gravity of whole blood, the red blood cells and

their hemoglobin content are more significant because of their greater weight.

Specific gravity of plasma. The steps for determining specific gravity of plasma are exactly the same as those described for whole blood, except that 2 drops are used from each pipette and No. 3 standard (specific gravity 1.0268). The determination is easier because there is no tendency toward coagulation.

For heavy plasma tube P₁ is used (specific gravity 1.0230), for lighter plasma tube P₂ (specific gravity 1.0130). Again the falling time of the plasma is checked against the falling time of the standard and the true density difference is added or subtracted to the corrected specific gravity of the standard.

It is this plasma specific gravity from which the proteins are calculated. It is the plasma specific gravity test which is routinely done on all pre-operative cases, the whole blood specific gravity is determined only in those cases in which difficulty is anticipated or when the course of the patient is being followed at the bedside during emergency treatment.

PROTEINS

In 1927, Atchley and Benedict, after a careful study of the electrolyte distribution in a case of severe intestinal obstruction, suggested that a simple determination of serum protein content might be the best aid in following the degree of dehydration and treatment.

In 1929, Moore and Van Slyke showed that there is a constant relationship between the specific gravity of the serum or plasma and the protein content. For plasma they expressed this relationship by the formula $P = 343(G - 1.0070)$, in which P equals the grams of protein per 100 cubic centimeters of plasma and G equals the specific gravity of the plasma. This work was done on human plasma and the maximum deviation was found to be 0.6 gram per cent.

Weech, Reeves, and Goettsch, in 1936, checked the work of Moore and Van Slyke. In their studies specific gravities were determined by pycnometry and nitrogen determinations by the micro-Kjeldahl method. Their formula for plasma was given as $P = 340.1(G - 1.00687) \pm 0.103$. It is this formula which we have routinely used.

We have rechecked Weech's formulas for both serum and plasma using a series of unselected clinical cases, and have found it to be

¹May be obtained from A. R. and J. E. Meyland, New York City.

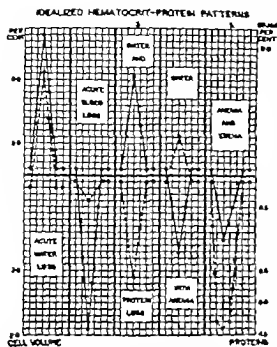


Fig. 4. These patterns represent idealized, superimposed, graphic histories of the changes in cell volumes and plasma protein determinations on several cases of each type. (In the line element eliminated for the sake of brevity in comparative representations. Each curve begins at hematocrit reading just above the normal heavy black line; the proteins just below the line and each returns to the beginning position.

Column 1. Acute water loss. Here there is marked hemococoncentration and dehydration as indicated by the rise in both cell volume and protein level. Such pattern is typical of conditions in which there is excessive vomiting, severe diarrhea, diminished fluid intake, or uncomplicated shock.

Column 2. Acute blood loss. Hemorrhage gives picture of steadily falling hematocrit reading and moderate protein loss.

Column 3. Water and protein loss. This is the picture so characteristic of severe burns, to slightly less degree in ruptured peptic ulcer, ruptured appendix, all peritonitis, and persistent fistulas from the bowels.

Column 4. Water loss with anemia. Relative hyperproteinemia in the presence of secondary anemia of chronic illness is fairly reliable index of the degree of dehydration.

Column 5. Anemia and edema. All values are below the normal line. When proteins reach concentration of less than 2.5 grams per cent functional disturbances related to the water content of the tissue may be expected. Below 2.0, true edema usually supervenes.

very accurate when the protein percentages, as calculated from the specific gravity determinations were checked by the standard micro-Kjeldahl method for nitrogen determina-

tion.¹ Comparing the mean average between the determined and calculated protein values in one series, we found that the difference amounted to ± 0.16 gram per cent or 2.3 per cent.

The essence of the relationship is that plasma, completely free of protein has a specific gravity of about 1.00687. Only rather large changes in the salt content of the blood upset this constant. The factor of 3.40 indicates that for each increase of 1 gram per cent of protein the specific gravity rises 1/340 or .00294. In other words, each increase in the specific gravity of 0.001 indicates 0.03 gram per cent increase in protein.

By this method the total protein content values are open to question in several types of cases that have come to light so far. They are gross hemolysis, severe diabetes, hypercholesterolemia, gross lipemia, and excessive bilirubinemia.

To facilitate the rapid calculation of the total protein content of the plasma from the plasma specific gravity determinations, a chart with comparative values already worked out has proved of assistance. The following is a condensed form of such a chart.

Specific gravity	Protein Grams per cent	Specific gravity	Protein Grams per cent
1.012	2.38	1.012	2.38
1.013	2.42	1.013	2.42
1.014	2.46	1.014	2.46
1.015	2.50	1.015	2.50
1.016	2.54	1.016	2.54
1.017	2.58	1.017	2.58
1.018	2.62	1.018	2.62
1.019	2.66	1.019	2.66
1.020	2.70	1.020	2.70

INTERPRETATION OF STUDY

A fairly definite idea of the history and clinical picture of the patient should always be sought before a final evaluation of the state of hydration is made from the data given by the preceding tests. Most important is the trend toward or away from normal as judged by repeated tests and not a single set of determinations. Certain well defined patterns have recurred many times in following a large series of cases, and these have proved of great aid in the interpretation of the values in any specific case.

In the medical and surgical laboratories through the kindness of Dr. Dana W. Archley and Dr. Louis Rosenberg.

In *simple dehydration* (Fig 4, column 1), whether from lack of fluid intake, diarrhea, excessive sweating, severe vomiting, or shock of a psychogenic, traumatic, or postoperative origin uncomplicated by hemorrhage, there is a rise in the cell volume, the whole blood and plasma specific gravity, and the plasma protein percentage. In the first 3 of these conditions, treatment consists in administering fluids until these elevated values tend to approach normal. In shock, however, the mechanism is more complicated, hence treatment, to be rational, must attempt to overcome first the severe arteriolar and venular spasm, second, the capillary paralysis and dilatation, and third, the great loss of circulating blood volume. Hypertonic sodium chloride is particularly effective in relieving this arteriolar spasm, in decreasing the viscosity of the blood, and in aiding the return of fluid from the tissues into circulation. It should be used cautiously in collapse due to dehydration (26). Suprarenal cortical hormone (eschatin) has proved valuable in restoring capillary tone, raising the blood pressure, and redistributing electrolytes. To maintain any gain initiated by the sodium chloride and eschatin therapy, blood transfusions are given as dictated by the findings on repeated blood studies.

In *hemorrhage* (Fig 4, column 2), either obvious or concealed, there is an immediate fall in the specific gravity of the whole blood and a drop in the cell volume as determined by the hematocrit. The plasma specific gravity changes are less marked (26). Even in severe hemorrhage, these values may not be abnormal due to readjustments of plasma proteins and circulating volume. They do not approach the percentage loss of cellular elements as indicated by the fall in whole blood specific gravity and the hematocrit.

Treatment here consists of restoring blood volume by transfusions. It is of utmost importance in cases of shock when the patient is unconscious to determine whether that shock is complicated by hemorrhage or not. These simple tests can make this differentiation in the vast majority of cases.

When there is not only loss of fluid but loss of protein as well (Fig 4, column 3), there is a

tendency for the hematocrit curve to rise while the protein values continue to fall. Such patterns are typical of severe burns, ruptured peptic ulcers with peritonitis, and even ruptured appendices with large abscess formation as the result of a great pouring out into the peritoneal cavity of an exudate rich in protein. In these cases, the problem of water balance is doubly hard. The extreme hemoconcentration and shock, if present, must be combated by means of adequate fluid administration, yet, the already lowered protein concentration must not be reduced to the edema level which in most patients is reached at about 5 grams per 100 cubic centimeters of plasma. Ravdin and his colleagues have laid great stress on the part that such hypoproteinemia plays in the malfunctioning of tissues and organs, particularly after traumatic or operative insult.

When *acute changes take place in chronic disease* (Fig 4, column 4) in which there already exists an anemia and probably a hypoproteinemia, any one of the ordinary tests, i.e., red cell count, hemoglobin, or hematocrit determination, will not evaluate the true state of hydration. A combination of all these tests is necessary, in particular, the determination of plasma specific gravity. A sudden water loss is reflected by an increase in the weight of plasma before other changes become apparent. This resultant hyperproteinemia is relative. Treatment consists in reducing the protein values to approximately normal levels and then restoring the cellular elements of the blood by appropriate means.

Impending edema (Fig 4, column 5) may be suspected by a gradually falling plasma protein level. Such water logging of tissues is detrimental in any surgical condition. In severe burns local edema causes an early creeping of the tan, allowing infection at its periphery. In postoperative resections or anastomoses, the stomas become swollen and obstructed, the motility of the gut is lessened, and the tendency for ileus increases. A definite relationship exists between the water content of tissues and the healing of wounds, particularly in those cases in which catgut has been used as the suture material and its tensile strength is affected. Repeated determinations of the plasma protein content by an

easy but accurate method assist in the prevention of such complications.

There is no formula at present which will state in a simple manner the amount of fluid necessary to rehydrate any given dehydrated patient, nor is there any rule of thumb for the type of fluid to be used in each case. Certain precautions seem wise e.g., in cases of hemoconcentration in which the hematocrit reading shows over 60 per cent cell volume, it seems unwise to use large quantities of hypertonic solutions because of the danger of bringing into circulation cell water which is rich in electrolytes definitely toxic when present in the plasma in quantities greater than normal (26).

In the severely ill there may be a complete loss of the ability to utilize fluids of any type in almost any quantities until the severe spasm of the peripheral vessels is relieved and the consequent return to the circulation of the sequestered blood in the paralyzed peripheral capillaries.

The only safe way at present is to measure the degree of hemoconcentration or anemia, the degree of dehydration or edema, institute the therapy suggested by the findings, follow the curve of progress by repeated determinations, and evaluate the state of hydration day by day or hour by hour if need be.

SUMMARY

1. Four simple tests are presented in some detail which may be used as emergency measures in determining and regulating the state of hydration of acutely ill persons. They are (1) the determination of the cell volume of venous blood by means of the hematocrit (2) determination of the specific gravity of the whole blood by the modified Barbour and Hamilton method (3) determination of the specific gravity of the plasma (4) calculation of the plasma proteins from the plasma specific gravity by a simple formula.

2. By means of the data thus acquired one may determine degrees of water loss, water plus protein loss, anticipate the onset of shock, differentiate shock due to simple circulatory collapse from shock complicated by hemorrhage detect dehydration in the presence of anemia predict the approach of an

edema level of proteins, and direct treatment more rationally for the alleviation of any of these conditions.

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THE PROBLEM OF TUBERCULOUS EMPYEMA THORACIS

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TUBERCULOUS empyema is a problem both from the purely academic aspect of classification and from the practical aspect of treatment. The latter has been, and still is, a controversial point. We have been stimulated to review this subject because of the frequency with which we have been faced with this complication and also on account of the difficulties of treatment and the unsatisfactory results obtained.

In the past 30 years the use of pneumothorax has increased greatly and with it the incidence of tuberculous empyema. Among chest specialists there is agreement as to general principles of treatment. Unfortunately, however, the general medical profession although undoubtedly familiar with these principles, very often fails to apply them. Consequently many of the patients are seen at a stage when operative procedures cannot be carried out. It is generally accepted that prolonged unsuccessful palliative treatment leads to a high mortality. In spite of this there is a tendency to keep on with such treatments for months without benefit to the patient. Finally the disease spreads or the resistance is so lowered that more radical measures are impossible.

In this article we have reviewed 37 cases. The mortality has been high; the reasons for which we have attempted to analyze. The progress of the disease has been studied in individual cases in an effort to find out at which stage different treatment would have been more successful. In addition we would like to present a classification of tuberculous empyema based primarily on the etiological factors.

INCIDENCE

The incidence of tuberculous empyema reported by previous authors varies considerably. Reports in recent years have stressed

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the increasing incidence due to artificial pneumothorax. The following compiled from statistics given by Alexander (9) shows the frequency with which empyema may occur during the course of pneumothorax treatment. Ullrich, in 600 pneumothorax cases, reported 2 cases of mild empyema and 1 of severe mixed infection in 300 pneumothorax cases. One-sixth of serous effusions changed into pure tuberculous empyema. L. S. Peters, in 700 pneumothorax cases, found pleural effusion in 70 per cent pure tuberculous empyemas, in 20 per cent empyema in 7 per cent. Ernest Peters, in 100 pneumothorax cases, reports 1 of empyema. Kinsella found empyema in 10 to 12 per cent of his pneumothorax cases. Hayes, in 21 per cent of 151 pneumothorax cases. Jones and Alexander of 70 empyemas, 28 complicated pneumothorax.

Our own findings are shown in Table I. We would like to point out that in our own series there is a total incidence of 2.3 per cent. If, however, the cases of artificial pneumothorax are not included the incidence of empyema is then reduced to 0.5 per cent in a total of 1,371 cases. If only pneumothorax cases are considered the incidence is 0.9 per cent. That is, once a pneumothorax is induced the chances of getting an empyema are 20 times greater than if the patient were treated by other methods.

LITERATURE

In reviewing the literature on tuberculous empyema from 1915 to January 1939, we have been impressed by the relatively few comprehensive studies which have been made and what is more, by the comparatively few cases presented in the best studies. Prior to 1919 there appeared in the literature occasional references to tuberculous empyema, usually in the form of a case report. In this year Duboff reported a series of 20 cases of tuberculous empyema which occurred among

TABLE I—PRESENT SERIES

	Number	Empyemas	Per centage of empyemas	Dead or dying—per cent	Stationary or well—per cent
Total admissions	1 675	37	2.2	72.9	27.1
Total induced pneumothoraces	304	30	9.9	73.3	26.7
Total spontaneous pneumothoraces	22	7	31.8	71.4	28.6

Note: 81 per cent of empyemas were secondary to induced pneumothoraces.

902 patients. Of these, 48 had had artificial pneumothorax. Ten of the empyema cases occurred among those cases receiving artificial pneumothorax treatment. Duboff recognized the fact that induced pneumothorax was the most potent cause of tuberculous empyema and this is usually accompanied by extension of lung disease with rupture of the lung into the pleural space. In the treatment of his cases he aspirated for pressure symptoms and remarked, "None of our cases have been cured in the sense that the pleural space has been cleared of pus and has healed without persistent sinus and we have used all methods except thoracoplasty."

Strangely enough, 20 years later, it is apparent from our own study that artificial pneumothorax is the greatest single cause of tuberculous empyema and, what is more, the underlying etiological factor is that of lung rupture. The importance of a bronchopleural fistula apparently was recognized by Duboff and more recently has been confirmed by Coryllos.

Peters in 1921 reported 26 cases of purulent effusions occurring among 250 cases of artificial pneumothorax. Eight of these were cases of mixed infection and 18 were of the pure tuberculous type. Thoracotomy drainage was done on all the mixed infection empyemas. Six of the 8 died, 1 had thoracoplasty and was alive but not well, and 1 recovered. Of the pure empyema cases 10 were followed, 4 carried pus for 3 years in reasonable health, 2 were still under treatment, and 4 were dead. Peters recognized that the mixed infection empyemas were due to a superimposed spontaneous pneumothorax but did not come to the same conclusion about the pure tuber-

culous cases. In the treatment of the pure cases, aspiration was used to alleviate pressure symptoms.

Jehn, in 1921, in a non-statistical article drew attention to important facts which are fairly well accepted today. He cautioned against thoracotomy except in severe mixed infection, suggesting repeated aspirations with gas replacement (nitrogen), and advocated thoracoplasty soon after thoracotomy where the latter is done. He stated that thoracoplasty was especially indicated in cases in which pneumothorax and pleural exudate cause only partial collapse of the lung with a remaining open cavity in the uncollapsed portion. He also stressed the need to aspirate between thoracoplasty stages to obtain best results.

McKinzie, in 1922, stated that 5 per cent of serous effusions complicating artificial pneumothorax became purulent and not infrequently were converted into the spontaneous type of pyopneumothorax. He reported 28 cases of mixed tuberculous empyema which were treated by aspiration and air replacement, and by open thoracotomy drainage, with poor results.

Hedblom (6), in the same year, reported a series of 76 cases. He pointed out that aspiration of pure tuberculous empyema should not be carried out indefinitely because of the danger of mixed infection and of marked progressive thickening of the pleura. In such cases he advocated thoracoplasty. In the presence of mixed infection Hedblom advised prompt drainage, open or closed, with or without irrigation.

Mainin, in 1926, reported a series of 359 cases of pulmonary tuberculosis in which he was able to induce pneumothorax in 205 cases. In patients thus treated 46 per cent developed a serofibrinous effusion, 7.8 per cent an opalescent effusion, 5.8 per cent empyema, and 2.4 per cent empyema with fistula. He used aspiration, irrigation, and air replacement, and reported improvement but did not give his results in detail.

Archibald, in 1930, presented a classification of tuberculous empyema based on the type of fluid present in the pleural space. He divided his cases into three types. Type I,

TABLE II.—RESULTS OF VARIOUS TYPES OF TREATMENT—246 CASES

	Well per cent	Worse per cent	Dead per cent
Simple aspiration	30	30	40
Closed drainage	29		30
Open drainage	32	6	56
Thoracoplasty	35	3	30

*13 per cent improving.

seropurulent effusion with straw colored turbid fluid containing tubercle bacilli type II, purulent effusion positive to guinea pig type III purulent effusion with many contaminating organisms. Archibald reported a series of 34 cases treated by thoracoplasty, type I, 8 cases type II, 11 cases and type III 15 cases. In type I there were 3 practical cures and 5 cases were improved. In type II there were 4 improved and 2 practical cures. In type III he reported 7 on whom thoracoplasty was done, with 1 improved. In 8 cases simple thoracotomy was done but further operation was contra indicated and all did poorly.

The Empyema Committee Report (5) read before the American Sanatorium Association in 1931 was based on the replies of 56 surgeons from both continents concerning their method of treatment of tuberculous empyema. Nearly 50 per cent of the surgeons resorted to open or closed drainage in cases of type I and type II infection (Archibald). Table II indicates the results reported for various types of treatment in 246 cases.

The Committee's report, while interesting, failed to mention the number of bilateral cases. Any data which do not take this into account must of necessity leave room for great variations in the end-result. The Committee pointed out that "too much time must not be given to the so called palliative methods of treatment but that radical surgery should be advised early if the condition of the patient warrants the operative risk.

Carl Hedblom (7) in 1932 reported 143 cases of bacteriologically proved tuberculous empyema. He contrasted the results of palliative and radical surgical measures. In cases of tuberculous empyema without pyogenic infection, thoracoplasty cured 74.7 per cent in a group of 23 patients without any mortality. In the cases with pyogenic infection

64.4 per cent were cured or markedly improved and there was a 20 per cent mortality in a group of 59 cases. As a comparison those patients treated by palliative measures showed 21.4 per cent cured and a mortality of 32.1 per cent, in a group of 28 cases of pure tuberculous empyema. Of the mixed infection tuberculous empyemas 12.1 per cent were cured and there was a mortality of 42.1 per cent in a group of 33 cases. Hedblom concludes that eventually most patients with unobliterated tuberculous empyema cavities die of the condition."

Jones and Alexander in 1934 presented a study of 70 consecutive cases of tuberculous empyema, in which they followed Hedblom's classification. In 43 of the 70 cases thoracoplasty was resorted to with the result that 74.4 per cent of the patients were considered cured, 7 per cent were improved and there was a mortality of 7 per cent.

In the same year Rosenblatt reported a series of 21 cases of toxic tuberculous empyema treated by aspiration air replacement and the injection of 2 or 3 cubic centimeters of saturated alcohol solution of methylene blue. Rosenblatt reported 52 per cent cured and 48 per cent dead. Rosenblatt failed to classify his cases, nor did he say whether he was dealing with unilateral or bilateral disease.

MacDonald reported in 1936 that he divided his tuberculous empyema cases into two groups simple tuberculous and tuberculous with mixed infection. In the treatment of simple tuberculous empyema he favored aspiration and air replacement. In those cases of mixed infection in which the infection was mild he employed the same procedure. He resorted to drainage in those cases of mixed infection which were toxic. A total of 15 cases of mixed tuberculous empyema was presented. Eleven of these were severe and 3 mild. Of the severe cases 5 had extrapleural thoracoplasty and 6 "undecking" operations. Thirteen of his cases were then living 10 were well and working 2 were improved and there was 1 death.

Leaver and Hardaway in 1937 presented a total of 59 cases, 35 of which were pure tuberculous empyemas and 24 of which were mixed. They reported that 58 per cent of

750 artificial pneumothorax cases developed tuberculous empyema. Sixty per cent of these tuberculous empyemas were attributable to spontaneous pneumothorax superimposed on the artificial pneumothorax, while 40 per cent developed from clear fluid. Of a total of 35 cases of pure tuberculous empyema, 57.1 per cent were cured, 20 per cent were improved or still under treatment, and 22.9 per cent were dead. Of these cases 51.4 per cent had oleothorax alone, and 5.7 per cent of the cured cases had thoracoplasty in addition to oleothorax. Of the 24 cases complicated by mixed tuberculous infection 20.8 per cent were cured, 8.3 per cent were living but worse, and 70.9 per cent were dead. All cured patients required complete thoracoplasty.

Coryllos, in the same year, drew attention to the high frequency of bronchopleural fistulas in tuberculous empyema. By means of gas analysis of the pleural air Coryllos was able to demonstrate the presence and estimate the size of a bronchopleural fistula. He divided fistulas into 3 types: (1) punctiform fistulas, (2) fistulas of moderate size, and (3) large fistulas. He stated that "in pulmonary tuberculosis the production of purulent exudate in the pleural cavity or the change of existing clear effusion to purulent ones is always due to the development of pleuropulmonary fistula." He believed that in those cases in which the empyema is carried for months or years the fistula becomes sealed off, otherwise the pus would have been coughed up.

Woodruff, in 1938, reported a series of 147 cases, which he divided into pure tuberculous empyemas (group A) and tuberculous empyemas with mixed infection (group B). In group A there were 105 patients, of whom 28 per cent were dead, 29.9 per cent were resting, and 42 per cent were well and working. In group B there were 42 patients, of whom 59.5 per cent were dead, 23.8 per cent were resting, and 16.6 per cent were well and working. In this group of cases some patients were treated by irrigation with salts and dyes, some by oleothorax, and others by thoracoplasty. He concluded that thoracoplasty was of great value in groups A and B, the other measures being of some value in group A only. In conclusion Woodruff stated:

"Many of the dead who have not had thoracoplasty probably passed through a stage where thoracoplasty could have been done with minimal risk."

Penington, in 1939, concluded an article on tuberculous empyema with the following statement:

"In a small series of cases of tuberculous empyema an easily demonstrable rupture of a caseating focus in the lung was invariably found at autopsy."

"In an experimental study of the production of tuberculous pleural effusions in the rabbit it was found to be impossible to produce an empyema by simple inoculation of the pleural sac with tubercle bacilli even in a sensitized animal. Nor did subsequent trauma or pleural inoculation of whole blood lead to empyema. An empyema was obtained experimentally only when a caseating tuberculous focus extended from the lung to the pleura and ruptured. Apparently the presence of caseous material in a free pleural space is the necessary condition for the development of an empyema."

"Experimental and pathological evidence is thus in accord and supports the belief that tuberculous empyema in man is the result of the rupture of a caseating tuberculous focus through the pleura."

ETIOLOGY

The pleura can be infected in the following ways: (a) bronchopleural fistula, (b) direct extension from tuberculous pneumonic or bronchopneumonic disease, (c) hematogenous, lymphatic, and other rare sources, such as, needle puncture, tuberculosis of ribs and glands.

a. In the treatment of pulmonary tuberculosis there are certain complications which greatly alter the prognosis. Perhaps the complication most to be feared is that of bronchopleural fistula. When this occurs there is a pathway directly from the mouth to the pleural space, along which mouth organisms can travel. The degree of the pleural infection will depend on the size of the fistula. Clinical experience has shown that a large bronchopleural fistula often causes a dangerous mixed infection, whereas a small fistula may or may not be responsible for secondary infection of the pleural space. There are three common causes for a bronchopleural fistula in tuberculous lungs, namely: (1) tear of the lung due to the pull of an adhesion, (2) rupture of a small subpleural caseous focus, and (3) rupture of a large cavity.

When these causes are borne in mind, the presence of bronchopleural fistula in tuberculous empyema is understandable. The frequency and importance of bronchopleural fistula in tuberculous empyema was not fully appreciated until recently. Coryllos, by means of gasometric analysis of the pleural air was able to demonstrate bronchopleural fistula in all cases of tuberculous empyema. Further, the same author showed that there was a definite relationship between the size of a fistula and the degree of pleural infection. From this it would appear that the development of a tuberculous empyema signifies the presence of a bronchopleural fistula. It is reasonable to assume that the longer the fistula remains the greater are the chances of mixed pleural infection. Thus pure tuberculous empyemas frequently progress to the virulent mixed type of empyema. In our concept tuberculous empyema, like tuberculosis elsewhere, is not a static disease but one which is constantly changing. The pleural fluid which starts as a turbid yellow liquid containing acid-fast organisms may progress to thick greenish pus containing the same organisms. Later this purely acid fast empyema may become contaminated with other organisms. The time interval between the various phases varies in different patients.

In the section on "Incidence" it may be seen that, since the advent of artificial pneumothorax treatment, tuberculous empyema occurs more frequently than in the past. Coryllos has also shown that bronchopleural fistula occurs during the course of artificial pneumothorax in a high percentage of cases. The frequent and often undetected presence of bronchopleural fistula in these pneumothoraces accounts for the increase in tuberculous empyema which has occurred in the past 25 years.

b. A tuberculous pneumonic or bronchopneumonic disease is always associated with some infection of the visceral pleura. If the visceral and parietal pleural surfaces are in contact, this may result only in adhesions. However when there is a large amount of exudate before adhesions are formed the exudate collects in the pleural cavity as an empyema. If the pleural surfaces are sepa-

rated as in artificial pneumothorax, the exudate collects at the bottom of the pleural cavity, forming a pyopneumothorax. Once again it is evident that the presence of pneumothorax predisposes to the formation of tuberculous empyema.

c. Tuberculous empyemas developing from hematogenous and other causes are comparatively rare.

DIAGNOSIS

Diagnosis depends on tubercle bacilli in the aspirated fluid and the proper examination of the aspirated material. It is not absolutely necessary however to find tubercular organisms in order to diagnose tuberculous empyema. A patient having pus in the pleural cavity even though it is apparently sterile must be considered tuberculous if active disease is present in the lung. A certain percentage of empyemas fail to show organisms on examination of the pus, although it is likely that many of these would be found positive if the more refined methods of examination were used.

In the past year at the Grace Dart Home Hospital we have cultured all effusions, using the method of Guernon, and have found it to be most satisfactory. In many cases in which ordinary methods (smear and concentration) have failed to demonstrate acid-fast organisms, we have been able to do so by culture. By this method positive results may be obtained within 4 or 5 days. As compared with guinea pig inoculation, the period of diagnosis is materially shortened. Guinea pig inoculation, however should not be neglected and all fluid should also be cultured for pyogenic organisms.

An appreciable amount of fluid in the pleural cavity should be regarded with suspicion especially if it persists for several weeks. The physical and roentgenological signs are too well known for repetition here. We would like however to draw attention to certain serious types of cases.

a. Spontaneous Pneumothorax

H.McM. No. 330, male aged 4 years. Symptoms first noticed in January 1935, (th cough, night sweats, loss of weight and dyspnea. When pa-

tient was admitted to the Grace Dart Home Hospital there was found a left-sided empyema with a bronchopleural fistula and spontaneous pneumothorax. A moderate amount of disease was present in the right lung. Culture of the empyema fluid revealed acid fast organisms and *Streptococcus anhaemolyticus*. Despite frequent aspirations of 1,100 to 1,300 cubic centimeters once or twice a week, the clinical course was downhill. Patient lost weight rapidly, pulse was rapid and temperature high. Two months after admission, thoracotomy drainage was performed. The patient died 2 weeks after this operation.

This case illustrates the rapidity with which mixed tuberculous empyema may progress. Conservative measures of drainage, aspiration, and thoracotomy were ineffective. As the disease already affected both sides when patient entered the hospital, no other measures could be instituted in this particular case.

b Artificial Pneumothorax

G B, No 2874, male, aged 58 years. Onset of symptoms occurred in December, 1932. In January, 1934, artificial pneumothorax was induced on the right side. This pneumothorax was incomplete and inefficient, it failed to convert the sputum on account of an adherent upper lobe. Fluid was first observed on October 31, 1935, at which time pneumothorax was discontinued, but the air failed to absorb. In August, 1936, this patient, who was in reasonably good health up to this date, was suddenly seized with a paroxysm of coughing. He immediately raised from 4 to 6 ounces of fluid sputum and became increasingly dyspneic. After this his cough became worse and at times he would suddenly cough up large quantities of purulent watery sputum. He was admitted to the Grace Dart Home Hospital in a moribund condition on August 28, 1936, and died 1 week later.

This case illustrates the danger of continuing an incomplete pneumothorax and also the rapidity of downhill progress in the presence of mixed tuberculous empyema. It is very probable that in August, 1936, the severe paroxysm of coughing was associated with a ruptured adhesion, with consequent bronchopleural fistula and mixed infection.

C G, No 3025, male, aged 40 years. Onset of symptoms occurred in 1932. In January, 1933, a left sided artificial pneumothorax was commenced. After pneumothorax was induced, the patient did well and was an ambulatory case with negative sputum until May, 1937. At this time he experienced severe pain in the left chest, accompanied by

a sudden rise of temperature to 103 degrees. Within a short time purulent fluid formed in the left pleural cavity. Prior to May, 1937, the right lung was healthy. Within a month there was evidence of a marked bronchogenic spread to the right base. A review of the roentgenograms showed that a cavity at the left apex had ruptured prior to the formation of the empyema. The patient died August 13, 1937, and the clinical findings were confirmed by autopsy.

Although this patient had been doing well clinically for nearly 4 years, the pneumothorax had not collapsed the cavity. Later, rupture of the cavity resulted in bronchopleural fistula, bronchogenic spread, tuberculous empyema, and early death (Fig 1).

PROPHYLAXIS

As we have previously stated, the most frequent cause of tuberculous empyema is bronchopleural fistula. By following simple common sense measures it should be possible to curtail the incidence of fistulas. In cases of active pulmonary tuberculosis the most important preventive measure is the avoidance of effort. Activities which cause sudden changes in intrapleural pressures are especially dangerous. This is more particularly true of cases of artificial pneumothorax which are complicated by adhesions. A sudden cough or straining effort may result in the rupture of an adhesion. Many workers attempt to rupture adhesions by increasing the intrapleural pressures, thus hoping to improve artificial pneumothorax collapse. Such adhesions may contain lung tissue or may rupture at their pulmonary attachments, thus creating bronchopleural fistulas. The relationship between bronchopleural fistula and tuberculous empyema has been mentioned several times in this article.

We are of the opinion that adhesions under tension should be cut when possible. On account of technical difficulties, pneumonolyses cannot always be executed. In such cases, if pneumothorax is not efficient, it should be abandoned and replaced by surgical collapse. If, however, the pneumothorax is efficient, it may be continued but the activity of the patient should be drastically curtailed. Brown, in 1936, pointed out the relatively high incidence of inefficient pneumothorax with its attendant danger. In our own series the ma-

forty of tuberculous empyemas developed in cases in which pneumothorax therapy was continued long after it should have been abandoned. The continuance of an inefficient pneumothorax may result in one or both of two complications (1) spread of the disease from an uncollapsed cavity (2) tuberculous empyema secondary to ruptured adhesions and the resultant bronchopleural fistula (see Case of C G. here reported above)

CLASSIFICATION

- I. Tuberculous empyema with bronchopleural fistula
 - a. Complicating artificial pneumothorax
 1. Pure
 2. Mixed
 - b. Complicating spontaneous pneumothorax—
 1. Pure
 2. Mixed
- II. Tuberculous empyema without bronchopleural fistula.
- III. Same as type I or type II, with bilateral active parenchymal disease.
- IV. Idiopathic—
 1. Pure
 2. Mixed

The significance of bronchopleural fistula in relation to tuberculous empyema has been accepted for some time on purely clinical grounds. More recently however as we have previously mentioned Coryllos has demonstrated the frequency and importance of bronchopleural fistula in tuberculous empyema. Coryllos, using gasometric analyses of artificial pneumothorax cases was able to show that spontaneous pneumothorax occurred frequently during the course of artificial pneumothorax treatment. According to this author practically all cases of tuberculous empyema had a small or large bronchopleural fistula.

The classification presented here attempts to take into consideration this etiological factor and at the same time include others essential for treatment. Previous classifications of tuberculous empyemas have not completely taken into account the underlying etiological factors.

RESULTS OF CASES

In our series there was a total of 37 cases of tuberculous empyema. We wish to present brief summaries of some of these cases. Each case presented illustrates a different type of empyema indicated in the classification given

TABLE III—TYPES OF EMPYEMA

	Number	Unilateral	Bilateral	Unilateral without bilateral
Pure tuberculous empyema	26	14	12	2
Mixed tuberculous empyema			8	
Total	37	29	27	
Per cent		82	73	

Note: of 29 unilateral cases, 47 per cent, became bilateral.

TUBERCULOUS EMPYEMA WITH BRONCHOPLEURAL PLEURAL FISTULA

Unilateral pure tuberculous empyema complicating artificial pneumothorax. In this group there were 13 cases. The duration of the pneumothorax to the time of onset of fluid ranged from 9 days to 65 months. The time interval from the first appearance of fluid to the onset of empyema varied from 2 weeks to 14 months. The period during which surgery might have been done with benefit to the patient varied from 1 month to 2 years. In the majority of cases, however it was about 6 months. Although surgical intervention is indicated as early as possible in this group of patients, the urgency is not as great as in the mixed empyema types as will be shown. Under conservative treatment several of these cases became bilateral and consequently inoperable. Six of the patients have died, 3 are going downhill, and in 3 the course of the disease has been arrested. One case is stationary. Of the arrested cases 2 underwent thoracoplasty and one was cleared up by aspiration and air replacement.

Two of the 7 cases which became bilateral did so shortly after thoracotomy. The dangers of thoracotomy will be discussed later under "Treatment."

J. N. N. 770 male, aged 26 years. Symptoms of disease commenced 3 months prior to admission to the Grace Dart Home Hospital. One month after onset, left pneumothorax as induced. The patient progressed favorably until 3 days prior to admission, at which time he developed spontaneous pneumothorax superimposed upon the artificial. Fluid began immediately to accumulate in the pleural cavity. At first it was straw colored, then slightly turbid, and became frankly purulent 5 months later. No pyogenic bacteria were found by culture but many acid fast organisms were demonstrated. Thoracoplasty was commenced month



a



b



c



d

Fig 1 a, May 23, 1934 The left upper lobe is involved in a tuberculous lesion showing a large cavity. The right lung is comparatively clear. b, May 4, 1937 The pneumothorax on the left has collapsed practically all of the left lung *except the cavity at the apex*. Because the patient's sputum was reported negative by direct smear the pneumothorax had been kept up. c, June 30, 1937 The cavity

in the left upper lobe has ruptured and there is now a tuberculous hydropneumothorax on the left and an extensive tuberculous spread in the right lower lobe. d, July 13, 1937 Shows continued spread of the lesion prior to death. This case illustrates the dangers of allowing a contra selective collapse to be continued even if the patient is apparently doing well.



Fig. 2. a, left March 30, 1936. On the left side there is tuberculous hydropneumothorax with complete collapse of the lung except for some adhesion of the upper lobe. The right side is clear. b, February 1937. The result ob-

tained by thoracoplasty supplemented by phrenic operation. There is a large high stomach bubble in this plate and the level of the diaphragm is indicated by an arrow. The patient is sputum free and working part time.

after the empyema appeared. Four stages of operation in 11 were performed, with good but not complete obliteration of the empyema cavity. There was decrease in the amount of sputum, which did not turn negative until the thoracoplasty was finally supplemented by phrenic operation. The small residual empyema cavity healed after thoracotomy. The patient is now working part time as a truck driver 1½ years after his last operation and is sputum free (Fig. 3).

M. K., No. 87, male, aged 56 years. Symptoms of disease commenced 5 months prior to admission. One month before admission a right pneumothorax was instituted. Fluid formed within 1 month and it was negative for acid fast organisms but became positive within weeks. At no time were pathogenic organisms demonstrable. By means of repeated aspirations and air replacement the pleural space was gradually obliterated. The sputum, however, continued to be positive. This patient refused thoracoplasty and his condition is to present satisfactory healing empyema but open pulmonary lesion.

Unilateral mixed tuberculous empyema complicating artificial pneumothorax. In our series there were 4 cases of unilateral disease with mixed tuberculous empyema which developed

during the course of artificial pneumothorax treatment. The duration of the pneumothorax up to the time of onset of fluid ranged from 4 months to 48 months. The time interval between the onset of fluid and the development of empyema was comparatively short. In all of these cases thoracoplasty could have been performed at the onset. As we have stated previously the development of a mixed tuberculous empyema must be considered as a surgical emergency. In only 1 case did the period of operability extend to as long as 3 months. All the patients died within a short time of the onset of the empyema—1 actually within 5 weeks. Two of the 4 cases became bilateral; 1 patient had a thoracotomy and phrenic excision and survived for 1 year.

W. H. N., 380, male, aged 25 years. Onset of symptoms occurred 3 years prior to admission. Pneumothorax commenced on right side 6 months after onset. This was incomplete, with peripheral development. Approximately 8 months later fluid developed, and it became purulent 1½ months later. The sputum was positive and copious. Phrenic

exeresis was performed 2 months after the empyema had developed. Thoracotomy was performed 4 months later. The disease became bilateral and the patient died. There was a period of 3 months after the development of the empyema during which the patient's condition would have withstood thoracoplasty.

Unilateral tuberculous empyema complicating spontaneous pneumothorax. Of this type there were only 2 cases—one pure and the other mixed. In both, fluid developed within a few weeks after the onset of pneumothorax and rapidly became purulent. On both thoracoplasty was performed. In the case of the mixed infection it was done early and was preceded by thoracotomy. In both patients the disease is clinically arrested, but one has a persistent sinus.

TUBERCULOUS EMPYEMA WITH BILATERAL DISEASE

There were 27 cases with bilateral disease. Nine of these had been unilateral when first seen. Nineteen of the cases had pure, and 8 had mixed, empyemas. Twenty-two occurred during the course of artificial pneumothorax and 5 resulted from spontaneous pneumothorax. There have been 17 deaths, 7 are going downhill, in 2 the disease has apparently been arrested, and 1 case has not been traced. Both of the arrested cases underwent thoracoplasty, 1 of these was a mixed, and the other a pure, tuberculous empyema.

In an analysis of our cases (Table IV) we have been struck by the high mortality as compared with reports presented in the literature. This we believe is due to the fact that we have considered all cases instead of selecting only those suitable for therapy. A consideration of the patients who did well reveals the significant fact that 5 of a total of 6 cured cases had undergone thoracoplasty. After analyzing our own cases individually we are convinced that many would have been benefited by thoracoplasty had this procedure been instituted sooner.

TREATMENT

The development of tuberculous empyema must be considered as one of the gravest complications of pulmonary tuberculosis. Early recognition of the empyema is essential.

TABLE IV—ANALYSIS OF CASES

	Number of cases	Cured or arrested	Stationary or improved	Worse	Dead
Unilateral pure	14	4	improved	2	6
Unilateral mixed	5	1			4
Bilateral pure	12		1 stationary	4	7
Bilateral mixed	6	1	1 stationary		4
Total	37	6	4	6*	21*

*Not improved 72.9 per cent.

It is one of the few complications in which well timed surgical intervention may be a life saving measure. Certainly it is evident from the foregoing data that failure to intervene results in a high mortality. Once an empyema is diagnosed, the problem is no longer a purely medical one. The skilled co-operation and constant observation of a medicosurgical team is essential, so that at any stage in the development of the disease, if medical treatment seems inadequate, surgical measures may be rapidly instituted before the patient becomes a poor operative risk. Many of our patients show the rapidity with which serous fluid may progress to the empyema stage and, what is more important, the speed with which patients lose ground and pass from a condition of unilateral operable disease to one of bilateral inoperable disease.

Before deciding on the treatment of a case of tuberculous empyema, one must attempt to classify it as to the underlying etiological factors and as to the type of pus in the pleural space. In all cases of pulmonary tuberculosis in which pleural fluid is suspected the patient should undergo aspiration of the pleural cavity. The fluid should be examined, and, if it persists, should be re-examined at intervals of 3 weeks or oftener. It is important to remember that fluid in the pleural space is not a clinical entity but that there is usually progressive, active underlying disease. This disease is not static but is constantly changing, and at any time a ruptured subpleural focus or lung cavity may result in a small or large bronchopleural fistula. Such a complication changes the clinical picture. Treatment, therefore, must take into consideration not only the type of pus present in the pleural space but also the condition of the underlying lung.

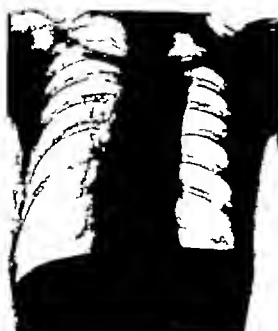


Fig. 4, left March 20, 1936. On the left side there is tuberculous hydropneumothorax with complete collapse of the lung except for some adhesion of the upper lobe. The right side is clear. b February 1937. The result obtained by thoracoplasty supplemented by phrenic operation. There is a large black stomach bubble in this plate and the level of the diaphragm is indicated by an arrow. The patient is sputum free and working part time.

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M. K. No. 57, male, aged 56 years. Symptoms of disease commenced 3 months prior to admission. One month before admission a right pneumothorax was instituted. Fluid formed within month and turned first as negative, then fast organisms but became positive within week. At no time were pyogenic organisms demonstrable. By means of repeated aspirations and replacement the pleural space was gradually obliterated. The sputum however continued to be positive. This patient refused thoracoplasty and his condition did not present stationary. With healed empyema but an open pulmonary lesion.

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W. H. N. 530, male, aged 35 years. Onset of symptoms occurred 1 year prior to admission. Pneumothorax commenced on right side 6 months after onset. This was incomplete. The patient died. Approximately 8 months later fluid developed, and it became purulent. The patient died. The sputum was positive and copious. Phrenic

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Fig. 3 a, left March 8, 1938 The left side shows rather culous hydro-pneumothorax. The pneumothorax is inefficient and the ca. tiles in the lung remain open. The lesions in the right lung appear hard and fibrotic b, April 25, 1938.



Following thoracotomy the left lung has expanded somewhat resulting in spread to the right side which now shows active exudative disease most marked in the lower hilar region and right lower lobe.

Aspiration with air replacement There is a small group of patients who respond to aspiration and air replacement or pleural irrigations alone. The majority do not and will require thoracoplasty with or without thoracotomy. We feel that pure empyema, developing secondarily to artificial pneumothorax with unilateral disease should be given a trial with aspiration and air replacement. The duration of this treatment should not be prolonged unless there is progressive diminution of accumulated fluid between aspirations. It may require 2 or 3 months of repeated aspirations in order to determine whether the empyema is improving or not. However one should not persist in this form of treatment even as long as 2 months if the patient is clinically going downhill inasmuch as thoracoplasty may be needed and should be started while the patient is in good condition.

In cases of bilateral disease with pure empyema, in which thoracoplasty is contra-indicated aspiration and air replacement may be of some value and should be continued. In

those cases in which fluid accumulates rapidly requiring 2 or 3 weekly aspirations of 400 or 500 cubic centimeters, there is either an extensive pleural infection or a large bronchopleural fistula. In this group aspirations should be abandoned within 2 weeks or less and thoracoplasty started immediately. It will be necessary to continue the aspirations between thoracoplasty stages. Here however aspiration is performed alone without air replacement.

Irrigations Generally speaking irrigations are of the greatest value in those cases with thick pus containing fibrin clots. For the first two or three irrigations it is well to use saline followed by an instillation of methylene blue for diagnostic purposes. In the absence of a large bronchopleural fistula other irrigating fluids may be used. At the Grace Dart Home Hospital Dakin's fluid has been the irrigating fluid of choice.

Surgical procedures Some of our cases illustrate that if surgery had been undertaken earlier there would have been a greater chance



Fig 4a

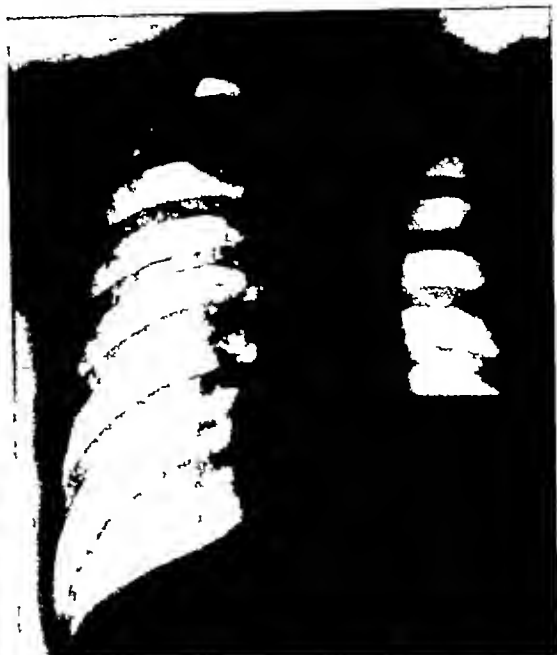


Fig 4b

Fig 4 a, January 30, 1936 The left side shows a pneumothorax with complete collapse except for an adherent apex. The right upper lobe shows signs of old disease but is comparatively clear b, May 12, 1937 A tuberculous hydropneumothorax is present on the left side The lung is collapsed except for the apex The right side is unchanged c, July 28, 1937 Following thoracotomy the cavity in the uncollapsed left apex opened widely and there was a spread to the right upper lobe Thoracoplasty was started in an attempt to close the cavity but was abandoned after the first stage This plate taken after the thoracoplasty shows the thoracotomy tube in place and the marked spread on the right side This case illustrates two dangers (1) that of continuing a pneumothorax with an adherent apex, (2) that of doing a thoracotomy before the apex is collapsed by thoracoplasty, thus running the risk of opening the cavity in the upper lobe with danger of consequent spread to the other side.

of survival As we have stated above, pulmonary tuberculosis is not a static disease There is an optimum period during which thoracoplasty can be performed for treatment of tuberculous empyema In many cases the period is very short

In the surgical treatment of tuberculous empyema there are two main objectives the first is the obliteration of the infected pleural space, the second is the maintenance of collapse of the diseased lung Both of these can be accomplished by thoracoplasty It is well known that thoracoplasty, as it is done today, *per se* carries a relatively low mortality rate



Fig 4c

For this reason it is necessary to subject patients with tuberculous empyema to thoracoplasty in the early stages of the disease

before there is a spread of the tuberculous process and before the patient has lost his resistance. In our own series many of the patients came to operation late for various reasons beyond our control. In spite of this, thoracoplasty was carried out with good results in a few cases. It is the only procedure which offers the tuberculous empyema patient any real hope of survival.

In cases of pure empyema thoracotomy should under no circumstances be performed. We have seen patients with pure tuberculous empyema drained by thoracotomy and there by develop severe mixed tuberculous empyema resulting in early death. The opening of the pleural space not only encourages secondary infection but results in re-expansion of the diseased lung. Previously closed cavities re-open and infected sputum accumulates. Very often this material spreads through the bronchial tree and infects the contralateral lung. We have seen 3 such cases, of which the following is an example.

J.G. No. 936, male, aged 5 years. Onset of pulmonary tuberculosis occurred in 934. The patient was admitted to the Grace Dart Home Hospital, January 937 with bilateral disease and left-sided cavitation. In April, 937 left pneumothorax was commenced. It was incomplete and did not close the cavity. The sputum remained positive, although the right side cleared almost completely. On December 5, 937 clear yellow fluid was aspirated from the left thorax. The fluid was frankly purulent by February 938, but failed to show organisms on smears. Roentgen-ray and physical examination carried out on March 8, 938 showed that the right lung was continuing to improve. On March 6, 938, thoracotomy under local anesthesia was performed on the left side, following which there was spread of the disease to the right or contralateral base. The spread is all shown in the ray plate of April 5, 938 (Fig. 3). The patient died May 7, 938, months after thoracotomy.

In the treatment of mixed tuberculous empyema one is faced with a more acute problem. A secondarily infected tuberculous empyema is a surgical emergency. Unlike other surgical emergencies (abdominal) the urgency is one not of hours but of days. Surgical intervention should be instituted as soon as possible after the diagnosis has been made. Thoracoplasty should be started before the patient loses his resistance even in the presence of fever and

toxicity repeated aspirations being employed to control toxicity. It is our belief that thoracotomy as a preliminary operation should be performed only when the empyema is fetid containing anaerobic organisms. Thoracotomy should be done only after the pulmonary cavity has been collapsed by one or two stages of thoracoplasty. We delay thoracotomy so as to prevent spread from a re-opened cavity as we have mentioned above (Fig. 4). In those cases in which a sinus persists after thoracotomy phrenic excision may be performed as it not infrequently aids in the closure of the remaining empyema space.

SUMMARY

1. Thirty-seven cases of tuberculous empyema, pure and mixed are analyzed and classified.
2. Eighty-one per cent of the empyemas studied were secondary to induced pneumothorax.
3. Mortality was 72.3 per cent.
4. A comprehensive classification of tuberculous empyema is offered.
5. The urgency of early surgical intervention in the mixed type of tuberculous empyema is pointed out.
6. The danger of prolonged conservative treatment in the pure types of tuberculous empyema is demonstrated.
7. The advisability of performing early thoracotomy in the presence of the mixed type of infection is questioned.
8. Early thoracoplasty seems advisable.
9. A review of the literature is presented.

Seven of our cases are studied at the Mount Sinai Sanatorium, Pritikin, Province of Quebec. Three cases of surgery reported were operated upon in Dr. Fraser Gird's service at the Grace Dart Home Hospital.

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INFECTIONS OF MENINGES AND BRAIN OF PHARYNGEAL ORIGIN

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INFECTION of the meninges and brain originating from the pharynx occurs in 2 ways (1) directly, by extension of a phlegmon of the parapharyngeal space, and (2) indirectly, by way of the blood stream, as in general sepsis. Each mode will be discussed separately and illustrative cases presented.

INFECTION OF THE MENINGES BY MEANS OF A PHLEGMON OF THE PARAPHARYNGEAL SPACE

This avenue of infection is well illustrated in a case which is of particular interest not only because of its uncommon occurrence, but especially because it was possible to reconstruct a puzzling sequence of clinical events by an extensive gross and microscopical study of postmortem material. That the clinical picture at the beginning was so obscure as to prevent the institution of timely surgical measures merely reflects again the guile with which disease processes betray the clinician.

CASE 1 A female, age 49 years, experienced intense pain in the right side of the neck on swallowing. The pain was first noticed when she awoke on December 13, 1937. There was marked tenderness over the right side of the neck. As the pain became progressively worse a laryngologist was consulted in the afternoon of the same day. He found the right palatopharyngeal arch to be markedly edematous and the lingual surface of the epiglottis on the right side and the right aryepiglottic fold similarly affected. The edema appeared to be non-inflammatory in character and suggestive of an angioneurotic edema (Quincke). Palpation elicited tenderness along the right side of the neck at the level of the

thyroid cartilage. A tentative diagnosis of angioneurotic edema was made, inasmuch as the patient had such a condition 4 years previously. At that time the condition disappeared within 1 day. Predicting against the foregoing diagnosis at this time, however, was a temperature of 102 degrees F. Ten cubic centimeters of calcium was injected intramuscularly and an adrenalin spray was prescribed. There was only slight improvement and the patient was subsequently admitted to the ear, nose and throat department of the Polyclinic in Vienna on December 14, 1937.

The patient experienced one chill on the day of her admission, but the tenderness of the neck and edema of the right palatopharyngeal arch diminished. At the same time, however, the edema of the entire epiglottis was found to be increased and appeared to be more of an infiltrative character. Laboratory findings: white blood cells, 14,500, polymorphonuclears, 85 per cent, immature cells, 5 per cent, lymphocytes, 4 per cent, monocytes, 5 per cent, eosinophiles, 1 per cent. Urine: albumen, 25, urobilinogen, increased. Microscopic examination revealed bacteria, leucocytes, and erythrocytes. Roentgenogram (Fig. 1) showed extensive swelling of the upper portion of the epiglottis, aryepiglottic folds, and around the arytenoid cartilages. The valleculæ were distended from below, in their ventral regions a number of rarified spots were seen, the borders of which were irregular and extended downward to the level of the anterior surface of the body of the hyoid bone. This was thought to be either an ulcer or an abscess.

Because of the massive swelling, the valleculæ were hidden from view by the apposition of the base of the tongue to the lingual portion of the epiglottis. The free portion of the tongue moved readily and was not swollen.

On December 15 the left submaxillary region was found to be slightly tender, the entire soft palate and uvula were swollen and wax-like in appearance, edema of palatopharyngeal arch was gone, tonsils were normal in appearance, and the epiglottis was extensively infiltrated so that it was "omega shaped." The vocal cords were hidden from view by the epiglottis. The right pharyngo epiglottic fold pre-



Fig. Extensive swelling of the upper portion of the epiglottis, aryepiglottic folds, and around arytenoid cartilages. F, floor of mouth; A, clear spots; E, epiglottis; Z, hyoid bone; D, arytenoid cartilage; C, thyroid cartilage.

scuted yellow area, probably submucous beneath the left pharyngo-epiglottic fold was thickened. The base of the tongue was greatly swollen; there were no chills. A treatment with heat lamp was given.

On December 6 pain on the opposite side (left) appeared for the first time and tenderness of the left submaxillary region was found to be present. The epiglottis remained the same as on the previous day. The base of the tongue was swollen more on the left than on the right side. Edema of the palatine arches and soft palate had disappeared by this time. On the left side of the vulva and on the left lateral wall of the pharynx defect of the epithelium was seen.

On December 7 trismus of moderate degree as present. The inferior pole of the left parotid gland was swollen. The epiglottis was firmly infiltrated. Tenderness of the left side of the neck in the supraclavicular region, region of the jugular veins, and the region of thyroid cartilage was elicited. Because of the diffuse tenderness and relatively slight rise in temperature to 100 degrees F, operation was postponed until the next day. On December 8 the patient was pale and slightly cachectic. A cardiac rate of 88 with compressible pulse was present. The posterior part of the larynx was visible. At this time the swelling of the epiglottis and the left lateral wall of the pharynx was of moderate degree whereas the swelling in the region of the left parotid gland was increased, but no fluctuation was present. During the afternoon of the pre-

vious day the whole left side of the neck and the superior part of the thorax were tender and slightly infiltrated. At this time the region of the jugular vein was not at all tender but the supraclavicular fossa was slightly painful to palpation.

The following indicated the need for operation: (1) cachectic appearance, (2) compressible pulse, and (3) increased swelling in the region of the parotid gland. Unfortunately operation was postponed because of the subnormal temperature of 97 degrees F and because the consulting internist found the pulse good and considered it to be a case of parotitis epidemica. In fact some of the people living in the house of the patient had such condition at the same time. On December 9, the parotid area was more swollen. A solid infiltration extended down and to the level of the thyroid cartilage and continued from there along the sternocleidomastoid muscle up to its insertion at the mastoid process. A circumscribed infiltration in the region of the left sternoclavicular joint was present. The infiltrated area was tender but not fluctuant. The larynx was not changed. Trismus was moderate and the patient showed definite pallor.

The temperature was 98.8 degrees F for the entire day. On December 10 the skin on the face was slightly yellow; the lips were dry and covered with crusts. The temperature was 98 degrees F. The left parotid was greatly swollen. The swelling extended into the posterior part of the neck to the clavicle and forward to the anterior border of the masseter muscle. The swelling throughout had sharp borders except for the region of the clavicle. The trismus was in normal position. Numbness of the facial nerve as present and there was no fluctuation. Blood count showed 5,800 leucocytes, polymorphonuclears 79 per cent, juvenile forms, 6 per cent, lymphocytes, 1 per cent, monocytes, 4 per cent, toxic granulations and many thrombocytes. The Wassermann reaction was negative.

At operation (H. Brunner) an incision was made along the sternocleidomastoid muscle from the mastoid process to the level of the cricoid cartilage. An abscess was found in the fascia colli in front and within the muscle. Exploration on the anterior border of the muscle revealed a cavity filled with thin, fetid pus. Tissue in the surrounding areas was necrotic. The parapharyngeal space along the blood vessels could be entered with the gloved finger. Pus flowed freely. The sheaths of the vessels were slightly thickened but otherwise normal. The jugular vein, which was normal, was exposed for about 5 centimeters for the purpose of ligation at a later date. If necessary, jugular lymph nodes were swollen and there was some evidence of black discoloration. As a final step the anterior mediastinum was exposed and revealed an edematous, necrotic tissue. No pus was found. Loose tamponade of the anterior mediastinum was carried out. An iodoform gauze drain was introduced into the parapharyngeal space.

The pus contained erythrocytes and scanty mixture of bacteria with gram-positive diplococci which

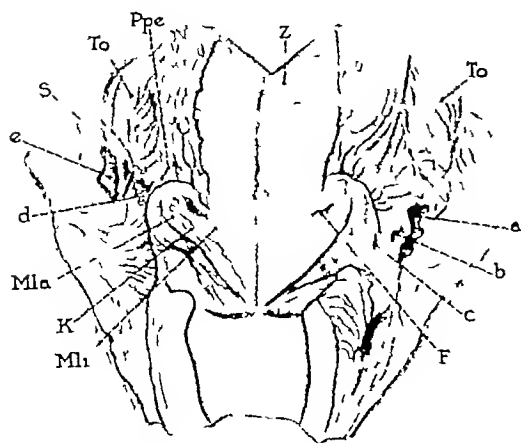


Fig 2 Condition present after opening the larynx Z, tongue split in the midline, To, tonsils, a, b, and c, ulcers in the lateral wall of the pharynx on the right side, F, fistula piercing the mucous membrane on the lingual side of the epiglottis, Mli, K, cartilage of epiglottis, Mla, mucous membrane on the laryngeal surface of epiglottis, d and e, ulcers in the lateral wall of the pharynx on the left side, S, probe passing through the fistula from the lateral wall of the pharynx into the parapharyngeal space, PPe, plica pharyngo epiglottica



Fig 3 System of channels produced by phlegmon a, Probe passing from the abscess within the parapharyngeal space to the base of tongue, Z, hyoid bone, S, thyroid cartilage, F, fistula piercing the lingual mucous membrane of epiglottis filled with barium.

appeared like pneumococci. Fine gram-negative bacilli prevailed. The culture revealed *Bacterium coli commune*, which at first grew anaerobically and later, after more implantations, aerobically. After operation on December 21 a slight general jaundice appeared. The wound was dry and showed diffuse necrosis but no pus. A slight euphoric state was noted. The swelling of the parotid gland, tenderness, and edema over the clavicle were not changed. Blood count showed 26,000 leucocytes, polymorphonuclears, 78 per cent, juvenile forms, 14 per cent, lymphocytes, 2 per cent, monocytes, 6 per cent, toxic granulations and toxic forms of nuclei. A blood transfusion was given. From time to time the patient was delirious. On December 22, progressive weakness was noted. In the evening she became unconscious and died.

Autopsy was performed on December 23. The dura was well stretched, the leptomeninges were delicate and very hyperemic. A hyperemia of high degree and petechial bleeding was present in the leptomeninges over the pons.

No abnormal contents were present in the abdomen. Both lungs evidenced slight adhesions onto the diaphragm, but otherwise were normal. The heart was the size of the fist of the cadaver. The tip of the heart was formed by the left ventricle. The wall of the left ventricle was approximately 12 millimeters thick and the wall of the right ventricle 4 millimeters thick. The heart muscle was very flaccid and had the color of loam. All parts of the heart were dilated. The valves, coronary arteries, and the great

arteries of the body were normal. The liver had a normal form, its parenchyma was lacerable and appeared cooked. The spleen was enlarged, soft, and its mass soft. The cortex of the suprarenal glands had no lipid deposit. Red patches were found in ascending groups in the right kidney. Red stripes extended from these patches and converged to the pyramids.

The following organs were given to the author for investigation (1) The organs of the neck. (2) A frontal disc, 5 centimeters thick through the base of the skull which included the ascending part of the mandible. This disc was cut anteriorly, in front of the sphenoid sinus through the posterior parts of the nose, the soft palate, and the junction of the horizontal and ascending parts of the mandible, and posteriorly, through the most anterior part of the petrous bones and the apex of the pyramid, downward along the anterior surface of the spine.

Diagnosis. Multiple abscesses of the base of the tongue followed by a phlegmon of the lateral triangle of the neck which extended into the parotid region and the pterygopalatine fossa, internal, suppurative, acute pachymeningitis in the region of the operculum sellæ and clivus, parenchymatous degeneration of the viscera, right ascending pyelonephritis.

Microscopic findings of special autopsy specimens. The following were normal: left submaxillary and lingual glands, floor of the mouth, large vessels of the neck, and the surrounding area on the right side.

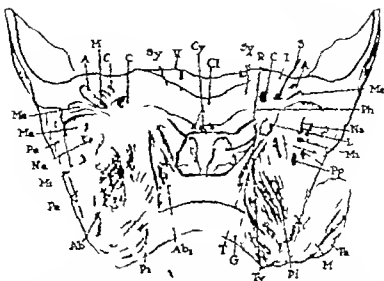


Fig. 4. Diagram of the posterior surface of specimen. A aurum mastoideum, M middle ear, Co cochlea, C internal carotid artery, Sy synchondrosis petro-occipitalis, V vulgus, Cy small cysts, Cl chorda, I capsule of the cochlea, S probe passing through the tube and the middle ear, Me secondary external meatus, Ph cut through the mucous membrane on the posterior wall of the pharynx, R groove of Rosenmüller, Va nerve sheath, Le left, P palatal muscle, M arteria maxillaris interna, Pp cess of the pterygoid plexus, T tenor, G gland, P parotid gland, M soft palate (cut through), Th thymus, Ab abscesses, P pterygoides externus.

The left side of the neck revealed recent, non-capsulated abscess about the size of bean along the posterior wall of the internal carotid artery between the jugular vein and carotid artery corresponding to the position of the sinus caroticus. The abscess reached the vagus but did not invade it. The lumen of the great vessels in the tissue surrounding the abscess was normal. The location of this abscess corresponded to the place where the sheath of the vessels had been opened at the time of operation.

The larynx opened by median incision reaching toward the hyoid bone and through the middle of the base of the tongue. After the larynx was opened the condition as shown in Figure 4 was observed. The sectioned base of the tongue, Z and both tonsils, T, were seen. Behind the right tonsil in the lateral wall of the pharynx (lateral part of the pharyngo-epiglottic fold) there was an ulcer about centimeter long and 4 millimeters wide. The ulcer had sharp irregular and undermined margins and a base composed of necrotic and purulent tissue. This ulcer was sharply demarcated from its surroundings and had no communication with the parapharyngeal space. Mesial to this ulcer as much smaller one of similar appearance to the first. By means of fistula covered with mucous membrane this ulcer

led into a third ulcer. The latter as just pinhead opening in the mucous membrane of the most superior part of the aryepiglottic fold. A probe introduced into this opening entered a larger cavity which communicated with fistula, F, which penetrated the epiglottis. This fistula as found in the greatest degree, edema, hemorrhagic, lingual, mucous membrane of the epiglottis, M. The cartilage K and the lingual, mucous membrane of the epiglottis, M, were normal. The fistula, F, emptied into large ulcer, U, situated in the left pharyngo-epiglottic fold, Pp. This ulcer, U, as separated from another ulcer by a narrow bridge of mucous membrane. These ulcers, U, were two of the same appearance as the first ulcers, U, and. When probe, S, was introduced into the ulcer, U, it penetrated about resistance into the parapharyngeal space. I that space recent abscess as present located between the lingual artery and stylopharyngeal ligament and between the wall of the pharynx and the stylopharyngeal muscle.

I order to get clear view of the system of channels produced by the phlegmon at the base of the tongue the entire fistula, F, filled through the ulcer with barium paste. A roentgenogram of this specimen was then taken (Fig. 5). This picture



Fig 5 Large abscess in the parapharyngeal space between the ascending branch of the mandible and the pterygoid process *a*, Probes in the eustachian tubes, *b*, abscess within the parapharyngeal space filled with barium



Fig 6 Extension of the abscess sagittally *a*, Probes in the eustachian tubes, *A*, abscess filled with barium

shows the fistula extending above the hyoid bone around the epiglottis as a band about $\frac{1}{4}$ centimeter long and rather sharply bordered. Only in the midline is the barium a little irregularly outlined over the cut surface, so that the margins are somewhat effaced. The probe is seen to lead from the ulcer, *d*, (Fig 2) into the parapharyngeal space. This represents the route of the phlegmon of the tongue to the parapharyngeal space.

The phlegmon did not extend caudalward from the place of perforation. On the contrary, the phlegmon continued within the parapharyngeal space upward as is shown clearly in the second specimen. The anterior borders of the specimen are through the posterior ethmoid cells, the posterior part of nose, and the posterior wall of both maxillary sinuses. This entire area was of no significance. Of great significance is the posterior surface of the specimen (Fig 4). The specimen was prepared as follows. After it was learned that the retropharyngeal space was normal, the posterior wall of the pharynx, *Ph*, was cut off at its insertion at the roof of the pharynx. The soft palate, *G*, had already been cut off at autopsy. The roof of the pharynx presented remains of lymphatic tissue and some mucin filled cysts, *Cy*. The muscles of the palate on the right side were dissected, the levator veli palatine, *Lv*, was cut, and the tensor veli palatini, *Tv*, was left untouched. Finally, the posterior walls of the tube, *T*, were cut away on both sides so that both tubes could be probed. The probe on the right side entered the middle ear but this was not possible on the left side. The mucous membrane of the cartilaginous tubes was found to be normal. By further dissection, the following was found. The marrow of the clivus, *Cl*, was normal. The dura over the clivus was covered

by some thick pus, on each side the inferior petrosal sinus was located. Farther forward the branches of the trigeminal, *V*, and its accompanying veins perforated the dura. The petro occipital synchondrosis, *Sy*, connected the clivus with the petrous bones. Here both internal carotid arteries, *C*, were seen. On the right side the most anterior part of the cochlear capsule, *I*, and on the left, the most anterior part of the bony cochlea, *Co*, the middle ear, *M*, the most anterior part of the attic, *A*, and the anterior wall of the external auditory meatus, *Me*, were located. Below the base of the skull were seen the ascending ramus of the mandible, *Ma*, and more lateralward, the remains of the parotid glands, *Pa*. The cut wall of the pharynx, *Ph*, and the Rosenmueller fossæ, *R*, the cartilaginous portions of the eustachian tubes, *T*, are seen in the middle. The area, bordered mesialward by the processus pterygoideus and lateralward by the mandible, was of particular interest. On the right side the bundles of the internal pterygoid muscle, *Pt*, and imbedded in fat and loose connective tissue, the auriculotemporal nerve, *Na*, the internal maxillary artery, *Mt*, with some small accompanying veins and some larger but not thrombosed veins, *Pp*, belonging to the pterygoid plexus were located. At *a* there was a small vein surrounded by a peculiarly condensed tissue. This was examined microscopically.

Very marked changes were present in the left parapharyngeal space. The auriculotemporal nerve, *Na*, and the internal maxillary artery, *Mt*, are on this side, too, but the accompanying veins of the artery and the big veins of the pterygoid plexus on this side were involved in an abscess, *Ab*, about the size of an olive, situated between the internal pterygoid muscle, *Pt*, and the pterygoid process. This abscess perforated the internal pterygoid muscle,

A



Fig. 7. Right side, anterior view. *D*, dura; *P*, pterygoid process; *C*, internal carotid artery; *F*, fracture in the posterior frame of the foramen ovale; *A*, abscess within the narrow space; *S*, sympathetic nerve; *T*, tensor vel palatini muscle; *L*, levator vel palatini muscle; *Pz*, thrombophlebitis parietalis of veins of carotid plexus; *C*, internal carotid artery.

the levator vel palatini muscle in medial direction against the wall of the pharynx. The left maxillary artery and the inferior part of the external pterygoid muscle were examined microscopically.

In order to observe the extension of the abscess the cavity was filled with cotton pads soaked in barium paste. Figure 5 shows a large abscess in the parapharyngeal space between the ascending branch of the mandible and the pterygoid process. This abscess did not reach the base of the skull although the cotton pad was packed into the cavity with pressure. Figure 6 shows the extension of the abscess sagittally. The abscess did not reach the pterygoid process but approached the bony tube. Finally both pictures show that the marrow of the basilar bone was normal, that the right tube was patent in its extent, and that the left tube was obstructed at the junction of the cartilaginous with the bony tube.

After passing through the skull in the midline we found the sphenoid sinus and the marrow of the sphenoid body to be normal. The left cavernous sinus contained much pus there as no frank pus found within the right sinus. The left cavernous sinus contained the same bacteria as those found in the parapharyngeal abscess, bacteria similar in appearance to those of the flora of the mouth, mixed

A



Fig. 8. Right side, anterior view. *D*, dura; *P*, pterygoid process; *C*, internal carotid artery; *F*, fracture in the posterior frame of the foramen ovale; *A*, abscess within the narrow space; *S*, sympathetic nerve; *T*, tensor vel palatini muscle; *L*, levator vel palatini muscle; *Pz*, thrombophlebitis parietalis of veins of carotid plexus; *C*, internal carotid artery.

with streptococci and great number of fusiform bacilli.

Microscopic examination. The parapharyngeal abscess on the right side (Fig. 5,) A diffusely infiltrated fatty tissue containing small veins seen. The walls of these veins were infiltrated with purulent material. This infiltrate approached the endothelium and destroyed it in places. At other points the elastic layer as well as the endothelium showed evidence of involvement.

Thrombi and collections of pus were seen within the veins. Purulent, strip-like infiltrations starting from the veins invaded the surrounding fat. The small arteries were surrounded by pus but their walls were normal. Finally the sheaths of the nerves were infiltrated but the nerves themselves were found to be normal.



Fig 9 Right side *A*, Anterior, *p*, middle fossa, *D*, dura, *a*, thrombophlebitis purulenta of veins within the dura, *T*, cartilaginous tube, *Am*, middle meningeal artery within the foramen spinosum, *TP*, thrombophlebitis purulenta of veins of plexus pterygoideus, *AM*, abscess within a marrow space, *Te*, tensor veli palatini muscle, *L*, levator veli palatini muscle, *Pc*, thrombophlebitis purulenta of veins of carotid plexus, *C*, internal carotid artery, *Ca*, calcification of media of internal carotid, *Co*, bony capsule of cochlea

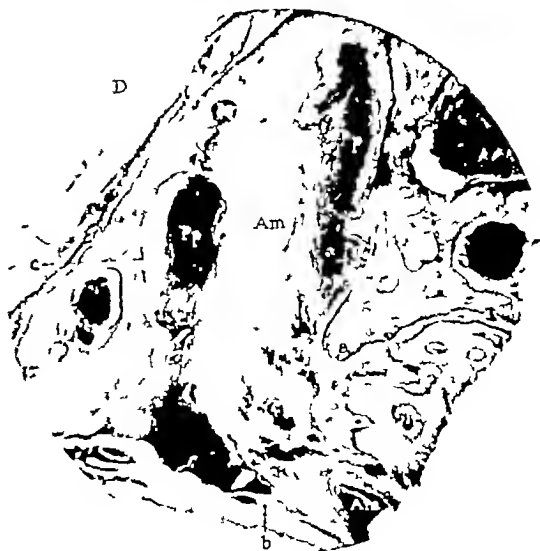


Fig 10 Right side *D*, Dura, *Pp*, thrombophlebitis of plexus pterygoideus, *a*, posterior border of foramen spinosum, *c*, anterior border of foramen spinosum, *b*, anterior and inferior border of foramen spinosum, *Am*, middle meningeal artery within the foramen spinosum

2 *The apex of the right temporal bone* The intima of the internal carotid artery was slightly thickened, the elastic layer was dissected and in some places the media was calcified (Fig 9). In the tissue surrounding the carotid artery, the carotid plexus was extensively thrombosed and abscessed (Figs 7 and 8). This purulent thrombophlebitis decreased in extent as the plexus was traced from the cavernous sinus to the knee of the carotid artery (Fig 11).

The cartilaginous and bony tubes and their lumina were normal except for some hyaline degeneration in the mucous membrane of the bony tube.

The apex of the pyramid (Fig 8) was diploetic and contained loose spongy bone, the marrow of which was partly lymphatic and partly fatty. For the most part, the marrow was normal.

The dura of the middle fossa showed an extensive, intradural and extradural suppurative process (Figs 7, 8, 9 and 11). The extradural suppuration, in many places, had broken into the marrow spaces of the tip of the pyramid and there produced abscesses of various sizes. Some bundles of the trigeminal, that are partly within and partly beyond the dura, were surrounded or destroyed by the suppuration. As in the case of the thrombophlebitis of the carotid plexus, intradural suppuration decreased lateralward in extent. In the lateral part of the middle fossa were many Pacchionian granulations and brain hernias, neither showing inflammatory changes.

The levator veli palatini muscle, fat tissue, and dense connective tissue (Figs 8, 9, and 11) were seen posterior to the cartilaginous tube where it is fixed to the inferior surface of the petrosal bone. Within that

fat and connective tissue are arteries of middle size which were normal, and many glands and excretory ducts of glands which probably belong to the glands of the pharyngeal mucous membrane. There were dense piles of leucocytes (periglandular abscesses) around some of these glands.

Anterior to the tube are the tensor veli palatini muscle and that part of the parapharyngeal space which lies just below the base of the skull (Figs 9 and 10). In that space lie the mandibular branch of the trigeminal before it enters the foramen ovale, and the middle meningeal artery as it enters the foramen spinosum. There was an extensive intradural suppurative process where the dura covered the bony margins of the foramen ovale (Figs 7 and 8a). The intradural infection extended farther by breaking through the posterior wall of the foramen ovale into the spongy bone and produced a big abscess within the marrow (Figs 7 and 8 *Am*). At another site a large fistula was seen in the posterior wall of the foramen ovale (Fig 7 *F*). Both margins of this fistula were dislocated and showed evidence of Howship's lacunæ but no osteoclasia. The opening of the fistula was filled with scar tissue consisting of many cells. At this place, although the suppuration had broken through the posterior wall of the foramen ovale in the direction of the cartilaginous tube, this particular fistula was already healed at the time of the patient's death. In spite of the extensive suppuration in the region of the foramen ovale, no evidence of suppuration was seen within the branches of the trigeminal that pass through the foramen.

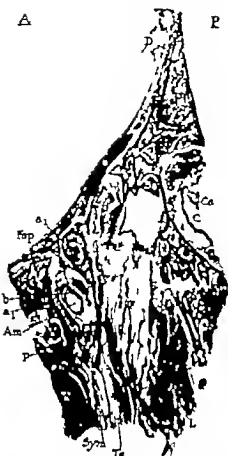


Fig. Right side. *D* Dura *Ca* bony capsule of cochlea, thrombophlebitis purulenta of sinus within the dura *F* foramen spinosum *Am* middle meningeal artery *Tn* transverse nerve *P* parathyroid gland *Te* tensor veli palatini muscle *L* levator veli palatini muscle *F* fat within the parapharyngeal space *B* cartilaginous tube *C* knee of internal carotid artery *C* calcification of tunica media of internal carotid artery *B* bony splits within the tube

A different sort of process was observed in the neighborhood of the foramen spinosum (Figs. 10, 11, and 12). The middle meningeal artery, as normal, and the branches of the sympathetic nerve which accompany the artery were almost normal. But in the loose connective tissue surrounding the artery there was an extensive abscess the result of purulent thrombophlebitis. This abscess undoubtedly was a continuation of an abscess within the parapharyngeal space which extended through the foramen spinosum into the cavity of the skull. Therefore the infection of the dura on the right side can be said to have originated therefrom.

3. *Th* ulcers in the right lateral wall of the pharynx (Fig. 13). In some places these ulcers reached the muscle layer of the pharynx. There was an inflammatory infiltration of moderate intensity in the connective tissue septa between the muscle bundles of the superior pharyngeal constrictor.

4. *Parapharyngeal space, the left side.* There was a suppurative thrombophlebitis of the small veins. The fat and the loose connective tissue on that side was more affected than on the right side. In addition to the ribbon-like infiltrations, considerable necrosis and masses of bacteria, hemorrhages and abscesses were noted. The purulent infiltration reached the media of the internal maxillary artery. The connective tissue sheaths of the nerves were infiltrated but the nerves themselves were almost all normal.

5. *Region of the left pterygoid process.* The veins of the pterygoid plexus were seen thin in the fat and loose connective tissue that surrounded both pterygoid processes. These veins contained either purulent thrombi or were thoroughly destroyed to form small and large abscesses. The large veins of the pterygoid plexus were, on the whole, normal. The terminal branches of the internal maxillary artery were also normal. It is surprising that the periauricular throes showed no or very little inflammatory change. The bundles of the pterygoid muscles were for the most part normal.

The marrow of the pterygoid process was partly fatty and partly mixed small abscesses were seen here and there. The bone and the pterygospinospharyngeal ligament were more resistant to suppuration, so that the ligament was not perforated, and the bone was perforated only in a few places.

6. *The jaw, the left temporal bone.* The changes here were essentially the same as on the right side, except that they were more extensive (Fig. 14). The terminal carotid artery showed thickening of the intima and calcification of the media. The thrombophlebitis around the artery was so extensive that in many places there were no veins at all but only frank pus. In many places the pus invaded the artery (Figs. 15 and 16). At these places the nuclei in the wall of the artery did not take the stain except where the endothelium was destroyed. The lumen of the artery contained a mural thrombus (Fig. 17).

7. *The extensive periarterial suppuration continued both along the knee of the internal carotid artery and that part of the artery that descends in the neck.*

The bony tube was normal and also the cartilaginous part, with the exception of the region of the isthmus of the tube. Under normal circumstances the mucous membrane is adjacent to the cartilaginous villi of the mucous membrane is seldom seen.

A study of the histologic tract was made by Leuker. In the nasal cavity following perianthelid abscesses, an abscess of the hard palate and subsequently examined three microscopically. The abscess could not be traced to the lateral wall of the pharynx. The abscess of the hard palate was only present in the lateral wall of the pharynx. The abscess of the hard palate was only present in the lateral wall of the pharynx. The abscess of the hard palate was only present in the lateral wall of the pharynx.

this case, the mucous membrane was in many folds which greatly narrowed the lumen. On some places that narrow opening was entirely closed by a serous exudate which developed in the following way. Under normal circumstances some cones containing connective tissue and blood vessels invade the cartilage of the tube, perforate the cartilage, and communicate with the subepithelial tissue of the mucous membrane. In our case, the blood vessels in these cones were hyperemic, at times also infiltrated, which gave evidence of their rôle in the transportation of infection, without affecting the cartilage, from the surrounding tissue into the mucous membrane of the tube. The marrow in the tip of the petrous bone was mixed. In many marrow spaces the marrow consisted of only lymphoid tissue which was a consequence of inflammation.

The dural veins were extensively thrombophlebitic and purulent so that big intradural abscesses were seen in a number of places. Extradurally, there was not much pus present. The superior petrosal sinus was thrombosed. There were many Pacchionian granulations in the dura of the lateral part of the middle fossa, but these were neither inflamed nor infiltrated. The branches of the trigeminal nerve, which perforate the dura, were also slightly inflamed. Only little pus was to be found in the Meckel's cavity. The gasserian ganglion was practically normal.

In that part of the parapharyngeal space, which is situated before the tube and before the tensor veli palatini muscle, big abscesses were seen and an extensive thrombophlebitis of the pterygoid plexus. These abscesses also surrounded the branches of the trigeminal and the sympathetic nerves, generally they did not invade these nerves. There was a split-like abscess in one place coming from the parapharyngeal space and traversing the trigeminal and adjacent sympathetic ganglion. The suppuration in the parapharyngeal space reached the ala magna of the sphenoid bone on the one hand, and on the other invaded the posterior wall of the foramen ovale and produced big abscesses in the marrow of the bone.

In the opening of the foramen ovale there was only a slight inflammatory change within the loose connective tissue between the bundles of the third branch of the trigeminal. However, there was an extensive purulent periphlebitis which accompanied the meningeal media artery through the foramen spinosum. Thrombosis seldom occurred. In the opening of the artery mural piles of leucocytes were found which lay in a network of fibrin. At these places the endothelium layer was almost absent which indicated the beginning of thrombosis. Otherwise, the wall of the artery and the bony walls of the foramen spinosum were normal.

The mucous membrane in the anterior part of the middle ear was hyperemic and inflamed. The wall developed pneumatic cells in the solid angle of the pyramid was lined principally with normal mucous membrane and only partly with edematous mucous membrane.

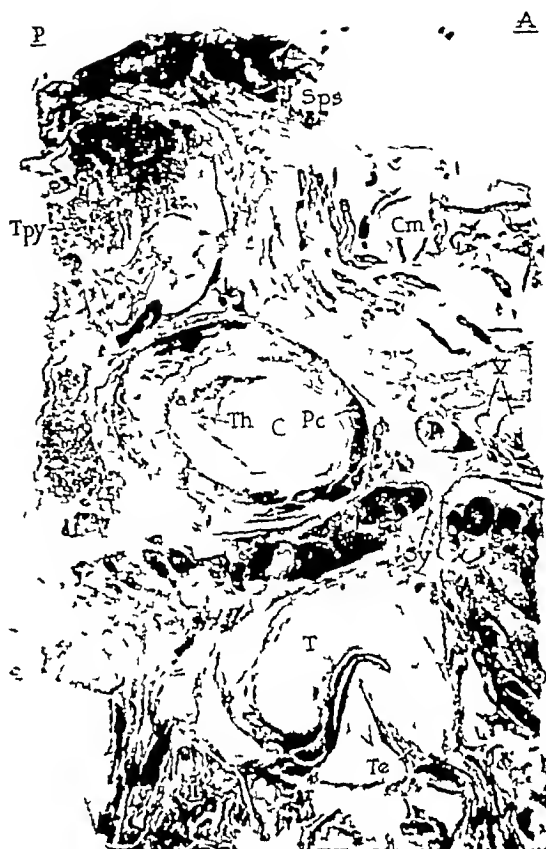


Fig. 12. Left side. *Sps*, Sinus petrosus superior (thrombosed), *Cm*, cavum meckeli, *Pc*, thrombophlebitis purulenta of veins of carotid plexus, *V*, trigeminal nerve, *P*, abscess within the dura, *Sj*, syndesmosis sphenopetrosa, *Te*, tensor veli palatini muscle, *T*, cartilaginous tube, *L*, levator veli palatini muscle, *Th*, thrombus within the internal carotid artery, *C*, *Tpy*, tip of the pyramid, *a*, space shown in Figure 13 in higher power, *l*, anterior, *P*, middle fossa.

7. *Cavernous sinus on the left side.* There was an extensive suppurative process reaching the media of the internal carotid artery. The media itself was normal. The connective tissue sheath of the nerves was only slightly infiltrated, and some small branches of the nerves were invaded by leucocytes.

It is obvious that in cases like these the most exact macroscopical examination is not sufficient to visualize the extent of the pathological processes. The microscopical examination of tissues which seem macroscopically normal is absolutely necessary. Consequently, quite enormous changes were discovered, the course of which can be traced only when cor-



Fig. 3. The space. In Figure 3, in higher power a, b internal carotid artery; c, all of the artery infiltrated; c, margin between the infiltrated wall (upward) and the necrotic wall (downward). P, thrombophlebitis paravascular of the carotid plexus. T, purulent thrombus.

related with the clinical features of the case. The patient's illness began with a phlegmon in the right half of the base of the tongue and in the neighboring lateral wall of the pharynx. Later the phlegmon extended along the base of the tongue and wandered from the right to the left. This explains the presence of ulcers in the lateral wall of the pharynx on both sides. These ulcers were connected by a fistula piercing the base of the tongue. The ulcers on the right side did not show a perforation of the constrictor pharyngis but on the left side an invasion of the parapharyngeal space undoubtedly took place. Consequently large abscesses developed in the loose connective tissue of the left parapharyngeal space as shown in Figure 4. From these abscesses, the infection continued partly downward and partly upward. The continuation of the infection downward followed the sheath of the vessels and might have been stopped by the operation. Of greater importance was the continuation of the infection upward into the cavity of the skull. Frank and Scheer studied the pathways of such infections and found it possible for the extension to proceed (1) along the veins in the form of a purulent thrombophle-

bitis (as a rule the order is as follows: veins of the pterygoid plexus, to the veins of the foramen ovale and then to the cavernous sinus) (2) directly as a phlegmon along the sheaths of the vessels and nerves into the foramina ovale, lacerum and spinosum and (3) by an osteomyelitic erosion of the bony base of the skull.

In this case there was purulent thrombophlebitis of the pterygoid plexus and of the veins in the foramen ovale; a slight infiltration of the sheaths of the mandibular branch of the trigeminal, an osteomyelitis of the posterior wall of the foramen ovale, and finally an extensive thrombophlebitis of the venous plexus around the carotid artery. In one word all pathways mentioned by Frank and Scheer were affected. It is important that the walls of the eustachian tube which were surrounded everywhere by pus, were not affected. The tube reacted only with the production of a little serous exudate filling up the lumen of the tube in the region of the isthmus and with the swelling of its mucous membrane which obstructed the passage of a probe on the left side. The wall of the carotid artery in the carotid canal was infected and the lumen at that place contained a mural thrombus.

The condition was too far advanced to permit a definite decision as to which pathway the infection followed to reach the endocranium. It is the writer's belief in this respect that the thrombophlebitis of the veins of the pterygoid plexus might have been of greatest importance. When it is recalled that in the microscopic specimen pus was seen within and around the vessels, it cannot be decided whether the pus had propagated upward along these channels or had sloped downward along these same channels. This question always arises in postmortem cases that have been examined. Consequently an unquestionable route of infection to the endocranium can seldom be uncovered. At any rate it seems that this question is of no great practical importance as even an exact knowledge of the pathway an infection will take into the endocranium would not make a rational regimen of treatment available.

When the infection in this case reached the endocranium it affected the veins within the

dura and the cavernous sinus As a result of this thrombophlebitis, many intradural abscesses of various sizes originated These intradural abscesses perforated the dura and produced extradural abscesses which finally eroded the bone of the ala magna It is not surprising that these intradural abscesses did not perforate into the arachnoid, since, as is well known, the endothelium of the dura is highly resistant As a result of this investigation, one observation is foremost both sides were similarly affected, though less on the right, despite the fact that no fistula was found on the right side, either grossly or microscopically, to account for a supposedly direct extension of the lingual phlegmon into the right parapharyngeal space

How are the pathological changes in the right parapharyngeal space to be explained? The thrombophlebitis of the right carotid plexus is most likely a continuation of the thrombophlebitis of the left cavernous sinus The route of infection was in the following order left cavernous sinus, intercavernous sinus, right cavernous sinus, and right carotid plexus An infection spreads along such channels very quickly, as reported by me many years ago This type of infection will explain why the thrombophlebitis of the right carotid plexus, which has not been as intensive as the thrombophlebitis of the left carotid plexus, decreases in the direction from the cavernous sinus to the knee of the carotid artery This last mentioned observation excludes the supposition that the infection of the right carotid plexus took place by way of an ascending infection from the right parapharyngeal space

Quite a number of other conditions must be considered as far as the suppuration in the right parapharyngeal space is concerned This suppuration was undoubtedly the result of the phlegmon in the base of the tongue, which started in the right half of the tongue That no perforation was discovered to lead from the right half of the tongue into the right parapharyngeal space proves nothing because a similar lack of a fistulous tract is often observed in parapharyngeal space infections of tonsillar origin Further, a preceding tonsillar infection can be resolved at the time when the phlegmon, which it produced within the para-

pharyngeal space, is still active and progressive

In conclusion, the course of the disease was as follows The phlegmon of the base of the tongue on both sides perforated into the parapharyngeal space, on the left side by an obvious fistula, but on the right by a fistula already healed supposedly at the time of death The infection of the left parapharyngeal space continued into the endocranium The chief routes were surely by way of the sheath of the carotid artery and the veins of the pterygoid plexus Within the endocranium the infection produced severe intradural suppuration and a thrombophlebitis of the left cavernous and intercavernous sinuses The infection then entered the right cavernous sinus and penetrated farther on into the right carotid plexus From the parapharyngeal space on the right side, the infection passed along the pterygoid venous plexus, through the foramen spinosum, and into the endocranium, too, which produced essentially the same changes as on the left side

It is proper now to reconstruct the clinical symptoms in correlation with the virulent infection On December 13, the patient acquired, for reasons unknown, a phlegmon of the tongue which wandered from right to left and which had been, as usual, associated with high septic temperature, moderate leucocytosis, and albuminuria The one chill that the patient had experienced and the tenderness of the left submaxillary region were direct results of the phlegmon of the tongue On December 17, 4 days after the onset of the disease, the temperature began to fall At the same time 3 symptoms appeared which indicated the seriousness of the disease had they been properly appreciated (1) trismus, (2) swelling in the region of the left parotid gland, and (3) diffuse tenderness of the left half of the neck In retrospect, we must explain these symptoms on the basis of the infection of the parapharyngeal space which occurred 4 days after the onset of the disease Unfortunately, we did not appreciate the value of these symptoms and did not operate at once

The subsequent course was peculiar Instead of the septic temperature usually encountered, the temperature fell to normal by

crises the local inflammatory signs of the throat improved, the swelling and the tenderness of the left side of the neck decreased which indicated an apparent improvement of the entire condition. Nevertheless the decision was made to operate because the patient looked sick, the pulse was soft, and the swelling of the parotid had increased. In failing to give sufficient credit to these symptoms 3 precious days were lost after the onset of the supposed infection of the parapharyngeal space. But on December 20, as soon as general decay swelling of the parotid and leucocytosis became increased and a slight jaundice of the sclera appeared, the operation was performed in spite of the low temperature of 98 degrees F. At operation a purulent necrosis of the connective tissue was found which reached the parapharyngeal space. There was very little pus. After operation the temperature rose slightly and the leucocytosis increased. The progress of the disease could not be stopped however and 2 days after operation the patient died of sepsis. The disease lasted 10 days in all and if we suppose that the infection of parapharyngeal space began on December 17 the inflammation in that area lasted 6 days.

When the clinical course is compared with the findings at autopsy the case reveals a number of significant findings.

1. The infection of the parapharyngeal space can manifest itself with the symptoms of a critical fall in temperature and of increasing leucocytosis. It is well known that some forms of sepsis, and indeed the most dangerous forms, can progress without giving rise to high temperature or even slightly elevated temperature. Roemau of my department in Vienna, described a case illustrating this fact. It is not well known that an acute sepsis such as this can also originate from the parapharyngeal space. It cannot be proved that *Bacillus coli* which was found to be present, was responsible for the peculiar features of this case although it is possible that this bacterium was the contributing factor.

Orton recently described cases in which the onset of a parapharyngeal infection was associated with a fall in temperature by lysis. I have also observed such cases. It should be

noted that in our case a critical fall in the temperature signalized probably the first involvement of the parapharyngeal space.

2. The autopsy findings indicate the possibility that the infection of the right parapharyngeal space took place many days before death. This supposition is supported by the fact that the fistula in the posterior wall of the right foramen ovale was filled with young connective tissue. Surprisingly this infection of the right parapharyngeal space happened without clinical signs many days before death symptoms such as swelling of the neck, serous catarrh of the middle ear or trigeminal neuralgia were all prominently absent. Only trismus existed which must be explained on the basis of the infection of the left rather than of the right parapharyngeal space. The conclusion to be drawn is that infection of the parapharyngeal space can exist without early alarming general, and local symptoms. This fact invites the suspicion that buccopharyngeal infections involve the parapharyngeal space more often than has been our belief. This conception has already been emphasized by Cobb and certain French laryngologists. Although Uffenorde does not believe this, the above tends to support the ideas represented by Cobb.

3. Symptoms of trigeminal neuralgia were absent, in spite of the fact that the parapharyngeal spaces on both sides were infected. In fact, the fibers of the trigeminal were only slightly affected the purulent infection was found principally around the nerve and gasserian ganglion. Of course it should be borne in mind that it is much easier to establish microscopically the basis for paralysis of a nerve than for irritation. However it is certainly true as Weassely remarked, that trigeminal symptoms are not present necessarily in all cases of ascending infections of the parapharyngeal space. We can make an even broader observation on the basis of this case, namely that neuralgic symptoms can be absent even when the surrounding areas of the trigeminal nerve are slightly involved.

4. Whether or not this patient had an acute serous catarrh of the middle ear is not known, because it was not investigated. But surely a blocking of the eustachian tube on the left

side existed, as evidenced by the inability to probe through the tube in the gross specimen. This blocking was the result of an inflammation of the mucous membrane in the cartilaginous tube, and this reaction in turn produced tufts and serous exudate. By what manner did the patient acquire tubal pathology? First of all, it did not result from an ascending infection along the tube from the pharynx. In order that this mechanism be considered, the tubal inflammation in such a case of bilateral infection of the parapharyngeal space as this would have to be bilateral. Instead, it was only on the left side. The idea of Wessely, namely, that the cartilaginous tube can be compressed by a parapharyngeal abscess, is not acceptable. The chief reason against this concept is the fact that the cartilaginous tube is surrounded everywhere by loose connective tissue and by fat. Also, at the point where the tube contacts the floor of the carotid canal it is separated from the bone by a thick layer of connective tissue. Consequently, if we still suppose that an abscess in the parapharyngeal space might compress the tube, it would be most essential that such an abscess be of an enormous size and continue to subject neighboring parts to great pressure. This again is not possible since the parapharyngeal space is not an entirely closed space.

The eustachian tube changes resulted from the infection passing along the connective tissue and blood vessels, which normally perforate the cartilage of the tube and extend thereby from the parapharyngeal space into the mucous membrane.

5 Our patient had an intensive intradural suppuration, a purulent thrombophlebitis of the cavernous sinus on both sides and of the carotid plexus on both sides. All these suppurations did not produce clinical symptoms. Eagleton has emphasized the lack of outstanding symptoms in certain cases of cavernous sinus thrombophlebitis. This writer made similar remarks many years ago regarding otogenous cavernous sinus thrombophlebitis. We, therefore, must disagree in this respect with Wessely's concept that "When the infection has spread over the base of the skull and reaches through the foramina ovale and spinosum into the endocranium, the typical

symptoms of thrombosis of cavernous sinus and meningitis precipitate." Our case proves conclusively that it is not always so. It is justifiable to state that when a patient dies of sepsis, originating from the parapharyngeal space, meningitis and thrombophlebitis of the cavernous sinus can be excluded with certainty only after these parts have been examined microscopically. Following up this postulate, we should definitely prove in similar cases, more often than we have in the past, the existence or non-existence of a latent meningitis and thrombophlebitis of the cavernous sinus which ordinarily are diagnosed only as *descending* infection of the neck. It will be necessary that microscopic examinations of the dura and the sinus be made even though they appear normal.

6 Twelve cases of deep abscesses of the neck occurred after buccopharyngeal infections were treated by the writer during the last few years, with 2 fatalities. When there was a chance to operate at all (a few of these patients died very rapidly), it was customary to drain the parapharyngeal space and usually to expose the jugular veins.

The present case indicates that this surgical procedure should not be followed routinely. At the time of the neck operation, the sheath of the blood vessels was found to be normal in spite of the purulent necrosis surrounding it. Nevertheless, this normal sheath was incised to expose the jugular vein. At autopsy, just at the site of exposure of the jugular vein an abscess was found. Undoubtedly, a route was opened up by incising the sheath unnecessarily at operation. Therefore, it is quite evident that at an operation for deep abscesses of the neck a normal sheath of the blood vessels should not be incised when there is purulent necrosis of the surrounding fascia of the neck.

INFECTION OF THE BRAIN BY WAY OF GENERAL SEPSIS

The second way in which infection may lead to the endocranium is illustrated by the following case.

CASE 2 Ch Sch, a female, 43 years old, had often had angina. On March 29, 1936, fever, chills, and a swelling of the neck appeared. It had been diagnosed as "abscess of the throat." After 2 days

the conditions improved but on the third day she ran a temperature of 100.4 to 101 degrees F. Since April 1 she could neither stand nor sit up therefore she was admitted to the neurological clinic. On April 2, the patient began to speak slowly and incoherently. She stretched her arms to other places than she wished to stretch them. On April 3 delirium occurred.

On April 4, her temperature rose to 101.5 degrees F. The soft palate on the left side bulged out. The region of the left tonsil was swollen, grimaces, dysarthria, and abductus paralysis on the left occurred. The right arm was paretic and ataxic abdominal reflexes on the right side were diminished both legs were paretic and ataxic abasia reflexes and toms on both sides were diminished. There were no signs of affection in the pyramidal tracts. On April 6, her temperature was 101.5 degrees F. The glands in the left mandibular angle were swollen, but the vessel sheath was not tender no trismus was present. The region of the left tonsil was very red the left tonsil was displaced by backward pressure. The palatopharyngeal arch on the left side was very much infiltrated, and large swelling and bulging out of the lateral wall of the pharynx extended down and to the larynx. The larynx could hardly be seen, but no edema and no disturbances of the mobility of larynx were present. There were 14,850 leucocytes in the blood. There was hemiparesis on the right side but the facial nerve was intact. Paralysis of the lateral movement of eyes to the left and upward was present. Language could not be understood. The cerebrospinal fluid was analyzed with the following results Pandy \pm Nonne Apelt \pm Nihil, α . Diagnosis tonsillogenous sepsis. Operation was refused. On April 7 swelling of the lateral wall of the pharynx increased and strabismus convergens occurred. There was no rigidity of the neck but positive Kernig was present in the evening the patient died.

In taking out the organs of the neck at autopsy a very well encapsulated abscess as big as walnut situated behind the left tonsil, was opened. The abscess cavity was filled with thick, creamy greenish pus. In the pus as well as in the blood, the Streptococcus hemolyticus was found. Both tonsils were enlarged and succulent. The follicles at the base of the tongue were swollen. The mucous membrane of the pharynx was very hyperemic. Trachea and esophagus were normal. The gray substance of the striated body and of the cortex cerebri were markedly hyperemic and spotted. No encephalitis was to be found a thin the pons. The vessels at the base of the brain were delicate.

The diagnosis as retroamillar abscess of the left side, septicemia subacute tumor of the spleen, parenchymatous degeneration of the intestine, edema and hyperemia of the brain, recent hemorrhagic nephritis and jaundice.

Microscopic examination revealed that the tonsils were hyperplastic and infiltrated by fibrous tissue. In that fibrous tissue many hyaline spots were to

be seen but no cartilage. Within the connective pharyngis muscle much fibrous tissue as to be seen in all sections of the brain hyperemia was found but no encephalitis. In one section thrombus consisting of leucocytes was identified.

In Case 2 edema of the brain was produced by a pharyngogenous sepsis. We cannot maintain, of course, that the parapharyngeal space and the meninges in this case were entirely normal since they were not examined microscopically. However it can be stated, that anatomically as well as clinically edema of the brain was prominent.

The finding of an edematous process of the brain in a case of general sepsis is not surprising since we know that in the course of a sepsis of any origin the brain can be affected in different ways. By toxins as well as by relay ing of cocci hyperemia, edema, swelling of the brain hemorrhage encephalitis, or a brain abscess can develop. As already mentioned in our case report an edema of the brain had developed. It is very important that this edema produced clinically only local symptoms of the posterior fossa. These symptoms were as follows (1) grimaces (2) dysarthria (3) abductus paralysis on the affected side (4) ataxia, and (5) hemiparesis on the right or healthy side. These symptoms led to the erroneous diagnosis of encephalitis of the pons.

An edema of brain some times can produce the clinical features of a disease localized within the posterior fossa. But even this finding is not surprising as we know that sometimes a non-inflammatory hydrocephalus can simulate the symptom complex of a cerebellar tumor. Nevertheless, it is important to know that a septic edema of the brain can simulate an encephalitis or a brain abscess within the posterior fossa. The importance of this fact will be elucidated by the very different prognosis. For while a brain abscess or an encephalitis impairs the prognosis of pharyngogenous sepsis to the highest degree this is not the case in so far as edema of the brain is concerned. We must remember that an edema of the brain can disappear if the sepsis is controlled either by surgery or by conservative treatment. The following case may prove this statement.

CASE 3 A M, female, 22 years old, had sometimes had angina. She became sick with intensive pain in the throat on January 8, 1937. The pain was localized first on the right then on the left side of the neck. On January 15, a peritonsillar abscess was found. On January 16, the condition became worse, she felt fatigue and her vision was diminished. There was no headache, but the patient experienced vertigo when she sat up. From January 16, she had strabismus. During the first 2 days of her illness she had high fever, later her temperature was only about 98.6 degrees F. Earlier she was a little drowsy.

On January 19, 1937, temperature was normal and there was no pain in the throat. The nose was normal, there was slight peritonsillar swelling on the left side. The submaxillary glands were slightly swollen on both sides, on the left more than on the right side. The glands were not tender, and the larynx was normal. The skull was diffusely tender. All nerves were tender at their point of exit from the skull, and there was slight rigidity of the neck. Lasegue's sign was slightly positive on both sides, nystagmus of second degree to the left, nystagmus of first degree to the right, vertical nystagmus upward. Paresis of the right abducens and slight paresis of the right facial nerve (?) were noted. The tongue, when put out, deviated slightly to the left, language was slow and scanning, flexion combined. The finger-nose test showed slight ataxia. There was slight hypodiadochocinesis on the left side, but not signs of affection of the pyramidal tracts. Tendinous reflexes were slightly increased on both sides. In Romberg position the patient would fall without certain direction. The cerebrospinal fluid was clear, Pandy \pm , Nonne-Apelt $-$, Nissl, 0.02, 6/3 cells. Urine was normal. Blood count showed 9,000 leucocytes. The diagnosis was encephalitis.

On January 21, the eye grounds were normal. Abducens paresis had decreased. Prontosil was administered. On January 23, new attacks of headache and projectile vomiting occurred. Looking straight ahead nystagmus was present. On January 25, there was very slight nystagmus of first degree to the right, on January 30, the patient felt well. Very slight nystagmus of first degree to the right was present. The caloric test revealed a normal irritability on the right side and a slight hyperirritability on the left side. The patient was dismissed from the hospital.

This patient was seen only 11 days after the onset of the disease. However, from the history it was learned that the girl became sick with a sore throat accompanied by a high temperature and general symptoms such as weariness, drowsiness, and vertigo, later a peritonsillitis on the left side developed. Eight days after the onset of septic angina the first local symptom of the brain, namely, a strabismus, was discovered. When the patient

entered the hospital, the peritonsillitis as well as the sepsis had decreased, but we were able to find symptoms which definitely indicated a disease within the posterior fossa. Those symptoms were the following (1) dysarthria, (2) paresis of the sixth cranial nerve on the right side, (3) ataxia, and (4) spontaneous nystagmus. These symptoms were accompanied by slight meningeal symptoms. As in Case 2, the diagnosis of an encephalitis was made. On account of our experience in Case 2 we must correct this diagnosis and must replace it by the diagnosis of an edema of the brain. We must do that all the more, since all neurological symptoms disappeared after a few days, so that the patient could be dismissed from the hospital.

CONCLUSIONS

Comparing the cases of the 2 groups described, the following can be concluded:

- 1 In the course of a pharyngogenous sepsis the meninges and the brain can become affected by means of a phlegmon of the parapharyngeal space or by a general sepsis.

- 2 The infection of the parapharyngeal space can occur without alarming general and local symptoms.

- 3 The infection of the parapharyngeal space can occur with a critical decrease in temperature and an increase in leucocytes.

- 4 Neuralgias of the trigeminal nerve can be absent in cases of phlegmon of the parapharyngeal space.

- 5 The blocking of the eustachian tube in a phlegmon of the parapharyngeal space occurs as a result of infection passing along the connective tissue and blood vessels, which perforate the cartilage of the tube under normal circumstances from the parapharyngeal space into the mucous membrane.

- 6 At operations for deep abscesses of the neck a normal sheath of the blood vessels should not be incised, when there is a purulent necrosis in the surrounding fascia of the neck.

- 7 When the infection of the parapharyngeal space reaches the contents of the skull, the meninges are infected first and intradural suppuration and thrombophlebitis of the cavernous sinus and of the carotid plexus develop. All these diseases of the meninges are, as a

rule accompanied by typical well known symptoms, but sometimes (Case 1) these typical clinical symptoms are missed.

8. In general sepsis the brain itself is affected first while the meninges are not at all involved or their infection is of secondary importance which is contrary to infections of the contents of the skull produced by way of a phlegmon of the parapharyngeal space.

9. The infection of the brain in general sepsis can lead to various pathological entities. In Cases 2 and 3 an edema of the brain was produced.

10. This septic edema of the brain can appear clinically as a disease which is localized within the posterior fossa.

11. Septic edema of the brain can disappear

entirely when the pharyngogenous sepsis is treated in the proper way and cured.

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FOREIGN BODY ARTHRITIS

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USUALLY when a foreign body enters a joint it is either removed relatively soon after the accident or it carries pyogenic infection into the joint so that a pyogenic arthritis develops. Occasionally, however, a foreign body enters a joint and is permitted to remain in or near the joint over a variable period of time. I believe that most surgeons feel that the continued presence of such a foreign body may injure the joint, but I do not think that much is known about the type or degree of injury which may occur. At any rate, I have not been able to find anything on this subject in the surgical literature. In this paper 6 such instances will be reported in detail.

CASE 1. A girl, 12 years of age, complained of pain, swelling, and disability of the right knee. Seven weeks before the examination a thorn had penetrated the lateral aspect of the knee just above the patella. This had been pulled out, but the next day the knee had been swollen and painful. The swelling had persisted and the pain had subsided with rest, but had returned with use of the extremity. At times there had been some elevation of temperature, but at no time had she been acutely ill.

On physical examination the right knee was moderately swollen, contained a moderate amount of excess fluid and was quite tender, especially over the lateral portion of the joint in the vicinity of the healed puncture wound. It was maintained in a position of slight flexion and movement of the joint was painful and markedly limited. There was some local heat and some thickening of the synovial tissues. The rectal temperature was 101 degrees F and the white blood cells numbered 10,500. The roentgenogram showed the soft tissue swelling but no evidence of bone change.

The patient was kept in bed for 2 days with the knee immobilized in a large hot wet dressing and the acute symptoms subsided but the swelling persisted. She was then permitted to walk and use the knee, and the acute symptoms reappeared and operation was advised. The roentgenogram showed soft tissue thickening and slight excess fluid in the joint but there were no visible changes in the bone (Fig. 1).

From the Department of Surgery of the Washington University School of Medicine.

Read before the American Rheumatism Society, St. Louis, May 15, 1910.

The knee was opened through a lateral incision. When the joint was opened a moderate amount of rather cloudy, straw-colored fluid escaped. The synovial tissue was moderately thickened and hyperemic. Over the lateral surface of the femur just above the cartilage margin there was an area about 1.5 centimeters in diameter where the synovial tissue was especially thickened and elevated above the surrounding surface of the joint. This area was excised and was found to contain a small bit of foreign matter (the tip of the thorn). The hyperplastic synovial tissue was then removed from the lateral portion of the joint and the wound was closed without drainage. The postoperative course was uneventful and the patient obtained an apparently normal knee.

Culture of some of the tissue removed at operation revealed no growth.

Microscopic examination showed marked thickening and increased vascularity of the synovial tissue. The blood vessels were thin walled and the connective tissue was youthful in character, consisted largely of young connective tissue cells, and was diffusely infiltrated with leucocytes and small and medium sized round cells. A few foreign body giant cells were seen in this tissue and some areas contained extravasated red blood cells. The synovial surface was intact and consisted of several layers of living, rather large synovial cells. This surface exhibited rather marked villus formation, the structure of the villi resembling that of the adjacent synovial tissue.

The pathological diagnosis was subacute arthritis, probably infectious in origin.

CASE 2. A man, 65 years of age, complained of pain and stiffness in the left knee. Approximately 45 years ago this patient received a bullet wound in the left knee. The bullet was removed about 3 months later. Apparently it had been embedded in the lateral condyle of the femur. There appeared to have been a low grade infection, as the wound drained for a few weeks after the operation. After the bullet was removed and the drainage had ceased, the knee was very stiff and has remained so. Not only was it stiff, but it was painful in damp weather or after an unusual amount of use.

Physical examination revealed movement in the left knee limited to about 30 degrees and accompanied by rather coarse crepitus. The knee was not tender and there was no excess fluid and no swelling. Roentgenograms showed narrowing of the joint space, irregularity of the femoral condyles, and considerable new bone around the articular margins of all of the bones (Fig. 2). The right knee was normal.

Diagnosis hypertrophic changes superimposed on an old infectious arthritis.

CASE 3. A woman, 5 years of age complained of marked stiffness, disability and moderate pain in the left knee. These symptoms had been of gradual onset over a period of many years. Roentgenograms revealed a foreign body apparently piece of needle about 3 centimeters long, embedded in the soft tissues in the anterolateral portion of the knee. According to the history this needle was stuck into the knee approximately 25 years ago. The right knee had caused her no trouble.

On physical examination the joint showed marked restriction of motion, marked crepitus on movement, and pain at the limits of movement. There was no excess fluid, but there was moderate peri-articular thickening and moderate tenderness. Roentgenograms showed complete loss of the joint space, marked erosion of the cartilage, and squaring of the condyles of the femur and tibia with a large amount of hypertrophic new bone around the margins of the joint. There was also spurring formation and cartilage erosion on the patella. The needle was seen lying in the soft tissues anterior to the joint space in the lateral view and opposite the medial side of the joint in the anteroposterior view. The right knee showed moderate hypertrophic changes and a joint mouse in the suprapatellar bursa (Figs. 3 and 4).

Arthroscopy was done. The needle was found embedded in the fat pad near the synovial surface. The needle was quit rusted and surrounded by scar tissue. The internal semilunar cartilage was fibrillated. This and some of the hypertrophied fat pad, including the needle, were removed. Also a considerable amount of new bone rounded the margins of the articular surfaces of the femur and tibia was removed.

The postoperative course was uneventful, except that the patient was relatively slow in getting back on her feet and the knee is still the site of hypertrophic changes. There is, however, marked improvement in the function of the knee.

Microscopic examination of the bone showed marked degeneration of the cartilage with disintegration and erosion, bare eburnated bone being exposed in some areas. The synovial tissue showed fibrosis, sclerosis of blood vessels, and some villus formation, the villi containing considerable amount of fibrous tissue. In the sections examined there was no synovial proliferation. However there was some infiltration in the subsynovial tissues and occasional medium sized foreign body giant cells were seen. These were surrounded by small round cells, but the structure was not typical of the changes caused by tuberculosis.

Diagnosis: hypertrophic arthritis of the knee due to foreign body.

CASE 4. A young woman, 29 years of age complained of pain and disability in the left ankle following turning it under her 7 years ago. She stated that the pain had been present since. She had been treated as a psychoneurotic. She then went to chiropractic college and had roentgenogram made which showed loose piece of glass in the ankle

joint, which was there diagnosed as fracture. Further history elicited the fact that 3 years ago a plate glass window fell on the left leg and she suffered a small cut in the calf of the leg which healed promptly and caused no further trouble.

New roentgenograms showed a piece of glass approximately $\frac{3}{4}$ of an inch long, $\frac{1}{4}$ of an inch wide, and $\frac{1}{4}$ of an inch thick lodged in the posterior portion of the ankle and lying in the space between the margins of the tibia and the fibula. There was definite narrowing of the joint space and also production of new bone around the margins of the ankle joint.

Through a posterior incision the foreign body was removed on October 6, 1935. Recovery was uneventful. Examination of the joint at the time of the operation showed thinning and some complete erosion of the articular cartilage of the superior surface of the astragalus and the inferior surface of the tibia, pigmentation of the synovial membrane in the region of the foreign body, and slight thickening and villus formation in the region of the foreign body. The piece of glass was lying loose in a cavity which was continuous with the synovial cavity and its lower extremity projected into the joint and rested on the superior surface of the astragalus.

Since there was only slight improvement in the patient's symptoms after the operation and since she continued to have pain on movement of the ankle and was not able to walk without support, she re-entered the hospital on December 5, 1935 at which time an arthrodesis of the ankle was performed with sliding graft from the tibia. She was discharged in a plaster cast and her recovery was uneventful. She is now walking well with a stiff ankle and has no pain.

Diagnosis: degenerative arthritis of the ankle due to a foreign body.

CASE 5. A man, 28 years of age, complained of pain and disability in the left foot. About 4 years ago this patient received a bullet wound in the left foot from a .38 caliber rifle. Apparently the bullet was lodged in the head of the astragalus. The wound healed without complications.

Roentgenograms which the patient brought with him showed large amount of opaque substance apparently lead in the astragaloscaphoid joint with marked narrowing of this joint space. This opaque material outlined the synovial surface of the joint and also extended down into the subastragaloid joint and more or less surrounded and extended into the head of the astragalus (Fig. 6).

At operation the astragaloscaphoid joint was exposed through a medial incision. The fragmented remains of the lead bullet were found to be embedded in the cartilaginous surface of the head of the astragalus. The surrounding cartilage was blue and gelatinous in consistency. This merged into areas in which the cartilage was very thin over the bone. The synovial surface was thickened and dark brown in color. As much of the synovial surface as could be reached from this incision was removed.

The remains of the bullet were removed from the head of the astragalus, the defect in the bone was saucerized, and the joint closed without drainage.

The postoperative course was uneventful. However, the patient still has some pain in the foot. This pain is aggravated by use and it may be necessary to arthrodese the joint.

Microscopic examination of the synovial membrane showed rather marked round cell infiltration with increased vascularity and moderate villus formation. In the deeper subsynovial tissues adjacent to the fibrous capsule, masses of amorphous material were seen. This was presumably lead. The articular cartilage showed necrosis and disintegration with some active regeneration as indicated by the presence of large cell nests surrounded by apparently necrotic matrix. The amorphous precipitate referred to was extracellular and encapsulated and in some places formed little globules. The capsule was of connective tissue and numerous foreign body giant cells were seen in the area. It is to be noted that in these areas there was little or no foreign material in the cells. There was considerable cellular debris in the joint and the hyperplastic synovial cells appeared to be migrating into the joint cavity. The masses of precipitate of lead were surrounded by cells and at times by giant cells, but there was very little tendency for the cells to phagocytize these masses. The method of removal appeared to be the inclusion of the precipitate by cells growing around it. There were practically no leucocytes.

Diagnosis: degenerative arthritis due to a foreign body.



Fig 1 Case 1 Slight soft tissue thickening and slight excess fluid in the joint 7 weeks after a thorn entered the knee. No bone change.

CASE 6 This consists of roentgenograms of a spine which were sent to me by Dr William K. Ishmael of Oklahoma City. According to the history this patient was injured 12 years ago when a rifle bullet entered the abdomen and lodged in the spine between the second and third lumbar vertebrae. He was severely ill on account of the abdominal injury, but recovered and states that the back has not at any time caused him any trouble. He consulted Dr Ishmael on account of pain in the heels which was associated with calcaneal spurs. The roentgenograms show the bullet still in its original position while the nucleus pulposus has disappeared and



Fig 2 Case 2 Marked degenerative and hypertrophic changes in the knee joint 45 years after a bullet wound in the lower end of the femur (probably infected).

CASE 3. A woman, 52 years of age, complained of marked stiffness, disability and moderate pain in the left knee. These symptoms had been of gradual onset over a period of many years. Roentgenograms revealed a foreign body apparently a piece of needle about 2 centimeters long, embedded in the soft tissues in the lateral portion of the knee. According to the history this needle was stuck into the knee approximately 35 years ago. The right knee had caused her no trouble.

On physical examination the joint showed marked restriction of motion, marked crepitus on movement, and pain at the limits of movement. There was no excess fluid, but there was moderate peri-articular thickening and moderate tenderness. Roentgenograms showed complete loss of the joint space, marked erosion of the cartilage, and squaring of the condyles of the femur and tibia with a large amount of hypertrophic new bone around the margins of the joint. There was also spur formation and cartilage erosion on the patella. The needle was seen lying in the soft tissues anterior to the joint space in the lateral view and opposite the medial side of the joint in the anteroposterior view. The right knee showed moderate hypertrophic changes and joint mouse in the suprapatella bursa (Figs. 3 and 4).

Arthrotomy was done. The needle was found embedded in the fat pad near the synovial surface. The needle was quite rusted and surrounded by scar tissue. The internal semilunar cartilage was fibrillated. This and some of the hypertrophied fat pad, including the needle, were removed. Also, considerable amount of new bone around the margins of the articular surfaces of the femur and tibia was removed.

The postoperative course was uneventful, except that the patient was relatively slow in getting back on her feet and the knee is still the site of hypertrophic changes. There is, however, marked improvement in the function of the knee.

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Diagnosis: hypertrophic arthritis of the knee due to a foreign body.

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joint, which was there diagnosed as a fracture. Further history elicited the fact that 5 years ago plate glass window fell on the left leg and she suffered a small cut in the calf of the leg which healed promptly and caused no further trouble.

New roentgenograms showed a piece of glass approximately $\frac{3}{4}$ of an inch long, $\frac{3}{4}$ of an inch wide, and $\frac{3}{4}$ of an inch thick lodged in the posterior portion of the ankle and lying in the space between the margins of the tibia and the fibula. There was definite narrowing of the joint space and also production of new bone around the margins of the ankle joint.

Through a posterior incision the foreign body was removed on October 6, 1935. Recovery was uneventful. Examination of the joint at the time of the operation showed thinning and some complete erosion of the articular cartilage of the superior surface of the astragalus and the inferior surface of the tibia, pigmentation of the synovial membrane in the region of the foreign body, and slight thickening and villus formation in the region of the foreign body. The piece of glass was lying loose in a cavity which was continuous with the synovial cavity and its lower extremity projected into the joint and rested on the superior surface of the astragalus.

Since there was only slight improvement in the patient's symptoms after the operation and since she continued to have pain on movement of the ankle and was not able to walk without support, she re-entered the hospital on December 5, 1935, at which time an arthrodesis of the ankle was performed with a sliding graft from the tibia. She discharged in a plaster cast and her recovery was uneventful. She is now walking well with a stiff ankle and has no pain.

Diagnosis: degenerative arthritis of the ankle due to foreign body.

CASE 5. A man, 2 years of age, complained of pain and disability in the left foot. About 4 years ago this patient received a bullet wound in the left foot from a .38 caliber rifle. Apparently the bullet was lodged in the head of the astragalus. The wound healed without complications.

Roentgenograms which the patient brought with him showed large amount of opaque substance apparently lead, in the astragaloscaphoid joint with marked narrowing of this joint space. This opaque material outlined the synovial surface of the joint and also extended down into the subastragaloid joint and more or less surrounded and extended into the head of the astragalus (Fig. 6).

At operation the astragaloscaphoid joint was exposed through medial incision. The fragmented remains of the lead bullet were found to be embedded in the cartilaginous surface of the head of the astragalus. The surrounding cartilage was blue and gelatinous in consistency. This merged into areas in which the cartilage was very thin over the bone. The synovial surface was thickened and dark brown in color. As much of the synovial surface as could be reached from this incision was removed.

However, the culture of the material removed at the operation was negative, the joint was closed without drainage, the wound healed by primary intention, and the patient made an uneventful recovery and obtained an apparently normal knee. It is thus evident that the infection, if present, was of a relatively mild type.

In Case 2 it is not known definitely whether the joint proper was infected or not, but it is probable that it was and that this infection was relieved by removal of the foreign body from the condyle of the femur about 3 months after the injury. This probable infection plus the foreign body remained in the joint long enough, however, to cause marked damage to the joint and resulted in a knee which showed marked degenerative arthritis and limitation of motion with pain after excessive use.

In the 4 other cases there apparently was no infection. The needle remained in the knee joint, or at least in the tissue near the synovial surface of the knee joint, for 25 years and was embedded in scar tissue. In this knee extreme hypertrophic arthritis developed while only moderate hypertrophic changes were present in the other knee. The relatively inert piece of glass in the ankle joint had apparently been there about 7 years, as the patient stated.

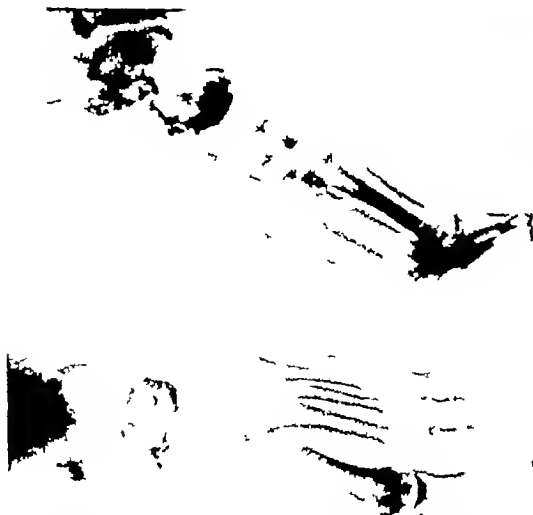


Fig 6 Case 5 The opaque material is a disintegrating lead bullet in the astragaloscaphoid and subastragaloid joints. Note the narrowing of the joint space.



Fig 5 Case 4 Anteroposterior and lateral views of the ankle before and after operation showing the degeneration and narrowing of the joint surface and some hypertrophic changes around the joint margin. On the left a piece of glass is seen in the lateral and posterior portion of the ankle joint. Later an arthrodesis of the ankle was performed with a sliding graft from the tibia.



Fig 7 Case 6 Anteroposterior and lateral views of the lumbar spine. Note the disappearance of the intervertebral disc and fusion of the vertebrae with the lead bullet lying in the bone and apparently causing no reaction around it. There were no symptoms. This is 12 years after the injury. (Case of Dr W. K. Ishmael)

that she had had symptoms in that joint for that period. As a result of the irritation there was marked degeneration of cartilage and the development of a hypertrophic arthritis which was so severe that after the glass was removed the joint remained so painful that an arthrodesis of the ankle was necessary in order to relieve the patient's symptoms.

In the case of the bullet which remained projecting into the joint for 4 years it is to be noted that the bullet was almost completely disintegrated; that minute particles of lead had spread and had been incorporated in the tissues over the entire synovial surface and that there was marked degeneration of the cartilage over the head of the astragalus and over the scaphoid. This degeneration extended quite far beyond the bullet and had progressed to such a degree that removal of the remains of the bullet, smoothing off of the bone and removal of most of the synovial tissue resulted in only partial relief and an arthrodesis may be necessary later. The bullet in the intervertebral disc caused degeneration of the disc and painless fusion of the bodies of the vertebrae.

It is thus evident that foreign bodies should not be permitted to remain in or near joint cavities. In some instances they may keep active a mild infection. In instances in which there is no infection they tend to cause degenerative arthritis and this arthritis is apt to progress more rapidly and to result in more destruction of the joint than is found to accompany joint mice which are pieces of the normal joint structure and may remain in a joint over a period of many years and cause relatively slight changes, although their presence does tend to cause the development of a slowly progressive hypertrophic arthritis.

In the case in which the piece of glass remained resting upon the posterior lateral portion of the superior articular surface of the

astragalus the degeneration of cartilage was widespread and it was most marked on the bearing surfaces of the joint. It is thus evident that a foreign body in a joint can cause damage to the articular surface other than by direct mechanical injury. The same is true of the piece of needle which lay adjacent to but not in the joint cavity.

In the case of the lead bullet in the astragaloscaphoid joint, it is interesting to note that this bullet was almost completely disintegrated and that the particulate material resulting from the disintegration of the bullet appeared to have been removed from the joint cavity by a process of inclusion in growing tissue and not as we would expect, by phagocytosis. In the sections examined no lead was seen in the bodies of any cells, although numerous small foreign body giant cells and macrophages were present. Apparently these cells refused to take up the minute particles of lead. However there was no extreme fibrous tissue reaction as masses of material, a large portion of which was found to be lead, were friable and found to be easily cut with a knife.

CONCLUSIONS

1. A foreign body in or near a joint cavity may serve to prolong and keep active a mild low grade infection and result in destruction of the joint.
2. A non infected foreign body in or near a joint cavity may cause severe progressive degenerative arthritis in the joint.
3. Foreign bodies in or near joints should be removed before the degenerative changes are produced.
4. Foreign bodies in intervertebral discs may cause degeneration of the disc and fusion of the bodies of the vertebrae. Unless they are infected they need not be removed, because the fusion causes no symptoms.

THE EFFECT OF SUBCASTRATIVE ROENTGEN THERAPY ON OVARIAN PHYSIOLOGY

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DISORDERS of ovarian function fall into several large groups of clinical importance. We are concerned primarily with the value of subcastrative amounts of x-rays in the treatment of anovulatory flow, temporary or prolonged amenorrhea, and sterility in the absence of demonstrable male or female causes or when associated with disturbed menstruation. We have discarded for this discussion those cases of ovarian failure with obvious congenital anomalies, or disorders of the ovary recognized as secondary to imbalance of other members of the endocrine system.

An abundance of literature exists concerning the use of various endocrine preparations for the correction of these conditions, but most of the reports are not quite conclusive. Subcastrative roentgen therapy has been presented as a very satisfactory therapeutic agent. The previous work in this field was done before or during the time when the pattern of the endometrium, as it reflected the ovarian sequence of follicular growth, rupture, and luteinization, was being unfolded. Hence the disorders of menstruation were not characterized as ovulatory or anovulatory, nor was the change in ovarian physiology brought about by roentgen therapy demonstrated.

On the basis of extensive biological studies, we may depend on demonstrable progestin effect in the endometrium as indicative of ovulation. The specific cytological changes evoked by progestin are well known (2, 5, 22) and are demonstrated in the accompanying photomicrographs. The term, menstruation, unqualified, has been used loosely for some time, but now it is properly applied only to the flow from such progestational or secretory endometrium. Flowing which is more or less

cyclical may come from a proliferating endometrium. Now, when such a flow in periodicity, amount, and duration resembles normal catamenia, it is called anovulatory menstruation.

We accept the theory that ovulation occurs from the sixteenth to the twelfth day, and usually about the fourteenth day before true menstruation. We assume, if biopsy reveals a secretory endometrium, that ovulation has occurred and that menstruation is to be expected within 14 days.

PREVIOUS REPORTS ON ROENTGEN THERAPY

Halberstaedter, in 1905, announced the specific sensitivity of the ovaries to x-ray, and according to Edeiken, Chereon, Duvel, Kronig, Seitz, and Wintz in 1910 to 1911, brought to the attention of roentgenologists the "stimulating" action of the x-rays on the ovary. In 1915, Van de Velde reported the return of normal ovarian function after small doses of x-ray had been applied over the ovaries. Beneficial results were presented often in the literature of the continent after that. As the activity of the anterior pituitary became linked with that of the ovary, similar small amounts of x-rays were given over the pituitary as a "stimulating" dose. Edeiken, in 1933, was one of the first to employ roentgen therapy in the United States. He reported 56 amenorrheic patients of whom 40 had return of normal periods, and 33 sterile patients of whom 14 became pregnant (1 patient twice) with no evidence of any harmful effect. Mazer and Spitz (19), in 1935, reported 102 cases of amenorrhea, oligomenorrhea, metrorrhagia, associated sterility, and primary dysmenorrhea, stating that well over half of the patients were benefited by the treatments. Kaplan (12, 13), Squire and Allen, Leavitt, Bromley and Phillips, Ford and Nelson, re-

that she had had symptoms in that joint for that period. As a result of the irritation there was marked degeneration of cartilage and the development of a hypertrophic arthritis which was so severe that after the glass was removed the joint remained so painful that an arthrodesis of the ankle was necessary in order to relieve the patient a symptom.

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It is thus evident that foreign bodies should not be permitted to remain in or near joint cavities. In some instances they may keep active a mild infection. In instances in which there is no infection they tend to cause degenerative arthritis and thus arthritis is apt to progress more rapidly and to result in more destruction of the joint than is found to accompany joint mice which are pieces of the normal joint structure and may remain in a joint over a period of many years and cause relatively slight changes although their presence does tend to cause the development of a slowly progressive hypertrophic arthritis.

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4. Foreign bodies in intervertebral discs may cause degeneration of the disc and fusion of the bodies of the vertebrae. Unless they are infected they need not be removed, because the fusion causes no symptoms.



Fig 1 Case 2, before treatment Proliferative endometrium, early Simple glands moderately dilated Glandular epithelium is columnar with beginning pseudostratification and frequent mitoses Stroma nuclei are small, closely packed, chromophilic, and are almost free of cytoplasm



Fig 2 Case 2, after treatment Secretory endometrium, twenty seventh day Serrated glandular epithelium with basal nuclei, fraying, and vacuolization of cytoplasm Prominent arterioles with thickening of surrounding stroma Cytoplasm of stroma cells has increased

treated, the ovaries and pituitary were irradiated at the same sitting Treatment was given at weekly intervals for three or four weeks In the average sized woman, a portal of 100 square centimeters was employed over the anterior pelvis, the lower border of the field being centered just above the symphysis pubis The pituitary was irradiated through a lateral portal of 80 square centimeters An exposure of 50 r's, air measurement, was given to each area

"One may assume that the ovaries lie at a depth of eight centimeters from the anterior surface of the pelvis and that the pituitary is seven to eight centimeters distant from the lateral surface of the skull Ionization measurements made in a pressed wood phantom give a surface dose, with back scattering of 66 r's Twenty-seven r's were delivered at a depth of eight centimeters, thus dissipating over half the dose to gain sufficient penetration

"The total dose to the ovaries, given in the four week period was therefore 108 r's, or 81 r's in the three week period A similar dose, perhaps slightly less, due to differences in conditions of back scattering, was delivered to the pituitary "

Both the ovaries and pituitary were irradiated in the majority of cases, the ovaries alone in several, but in no case was the pituitary alone treated Some of the patients received a duplicate series of treatments after an interval of 2 or 3 months It has been found that no injurious effects result if such an interval elapses between treatments Pregnancy should always be ruled out before a second series is started

EFFECT OF INSTRUMENTATION, HORMONES, RADIUM

Consideration must be given to other procedures or adjunctive treatments which were employed while attempting the relief of these patients It is a recognized fact that in cases of endocrine imbalance of this type any form of cervical instrumentation may be sufficient to tip the hormonal balance to normal Frequently, normal ovulatory cycles succeed previous irregularity, or pregnancy occurs following a period of infertility, after a simple dilatation of the internal os, a curettage, a cauterization of the cervix, or after an endometrial biopsy In one of the patients not included in this series, 4 endometrial biopsies were taken at weekly intervals before the patient could arrange for x-ray treatment, after which, ovulation promptly began Endometrial biopsy was necessarily involved in the study of all our patients, but as the large majority had been subjected to such a procedure unsuccessfully for months or even years before roentgen therapy was employed, this factor is presumably minimal

All specimens were obtained by the small suction curette according to the methods described by Klingler and Burch, Rock (21), Novak, Kurzrok, Rock and Bartlett (22), and

ported series and results, good or variable. All emphasized the importance of first ruling out pathological states as a cause of the menstrual disturbance of eliminating all but the functional ovarian disturbances, and the fact that no harmful effects had been noted. The technique of radiation was essentially the same as that employed in this group. Certain case results, in the Mazer and Spitz (19) group were evaluated by a study of the endometrium but the findings were not stressed. This we have endeavored to do in our series.

EFFECT OF ROENTGEN THERAPY ON THE OVARIES AND PITUITARY

The general action of the x rays has been deduced from their effect upon plant and animal life and upon clinical observations. Edelken points out that the theories brought forth to explain the action of x rays can be divided into 2 modes: (1) stimulation and (2) selective destructive action. The Arndt-Schulz law applied to the biological effects of the x ray states that small doses of x ray stimulate moderate doses inhibit, and large doses destroy vital processes. We are able to establish the upper limit, that of destructive action of the x rays since the sterilizing dose for the human female at various age levels is known. Whether the small dosages employed therapeutically in these cases would stimulate or inhibit is open to conjecture. Those who support the theory of indirect stimulation of the ovary report a few cases in which there was resumption of normal ovarian activity after roentgen therapy had been employed on the pituitary alone. It is additionally suggested that minimal exposure of the ovaries effects the destruction of a persisting follicle with its deranged estrogen production and thus allows a normal follicle to begin its maturation. Traditionally a persisting corpus luteum has been blamed for such failure of ovulation. But corpora lutea are notably resistant to x ray. Furthermore as a result of endometrial study we believe that a persisting corpus luteum which produces progestin sufficient to inhibit ovulation is extremely unlikely if it occurs at all save only in the early months of pregnancy. To us then,

the most attractive theory brought forth to explain good roentgen results is: A persisting follicle with its troublesome endocrine activity is destroyed and new follicles allowed to mature and to re-establish normal cycles.

Mazer and Spitz (19) for 3 years followed 11 normally menstruating women who had received this small dose of x-rays to both pituitary and ovaries. In no single case was the menstrual rhythm seriously or permanently affected. However all of the writers note a very low incidence (2 to 5 per cent) of temporary amenorrhea with or without hot flashes, nervousness, and the like suggestive of decreased or absent ovarian function. Whether this would have happened in these patients anyway or whether it was due to roentgen therapy is difficult to say but it does serve as a warning because older patients whose ovaries have lost the vigor of youth may be less tolerant of this treatment. This transient disturbance will be shown in a considerably higher percentage of our cases than is usually recorded. All other writers emphasize the absence of subsequent obstetrical disasters from fertilization of defective ova. In our series of cases there was 1 miscarriage in the early months of gestation. We cannot identify the cause. However should an abnormal ovum become fertilized it is unlikely that it would be carried to term (10).

We make bold to suggest that there is little value in x-ray treatment of the pituitary either alone or in conjunction with the ovaries. Hartman and Smith, in 1938 reported a study of 13 non-ovulating rhesus monkeys who were given a single dose of between 60 and 400 r's to the pituitary. There was no increase in ovarian size in 11 animals and in only 1 case did the animal ovulate. This is not unusual even without treatment. There were no harmful sequelae for in one third of the monkeys spontaneous ovulation and conception occurred in the following breeding season.

X RAY TECHNIQUE

"The factors employed were 300 kilovolts 50 centimeters focal to distance 0.75 millimeter copper equivalent filter. When the pituitary was

*As deeply indebted to Dr. Richard Deamer for treating our patients and for his description of technique.



Fig 1 Case 2, before treatment Proliferative endometrium, early Simple glands moderately dilated Glandular epithelium is columnar with beginning pseudostratification and frequent mitoses Stroma nuclei are small, closely packed, chromophilic, and are almost free of cytoplasm



Fig 2 Case 2, after treatment Secretory endometrium, twenty seventh day Serrated glandular epithelium with basal nuclei, fraying, and vacuolization of cytoplasm Prominent arterioles with thickening of surrounding stroma Cytoplasm of stroma cells has increased

treated, the ovaries and pituitary were irradiated at the same sitting Treatment was given at weekly intervals for three or four weeks In the average sized woman, a portal of 100 square centimeters was employed over the anterior pelvis, the lower border of the field being centered just above the symphysis pubis The pituitary was irradiated through a lateral portal of 80 square centimeters An exposure of 50 r's, air measurement, was given to each area

"One may assume that the ovaries lie at a depth of eight centimeters from the anterior surface of the pelvis and that the pituitary is seven to eight centimeters distant from the lateral surface of the skull Ionization measurements made in a pressed wood phantom give a surface dose, with back scattering of 66 r's Twenty-seven r's were delivered at a depth of eight centimeters, thus dissipating over half the dose to gain sufficient penetration

"The total dose to the ovaries, given in the four week period was therefore 108 r's, or 81 r's in the three week period A similar dose, perhaps slightly less, due to differences in conditions of back scattering, was delivered to the pituitary "

Both the ovaries and pituitary were irradiated in the majority of cases, the ovaries alone in several, but in no case was the pituitary alone treated Some of the patients received a duplicate series of treatments after an interval of 2 or 3 months It has been found that no injurious effects result if such an interval elapses between treatments Pregnancy should always be ruled out before a second series is started

EFFECT OF INSTRUMENTATION, HORMONES, RADIUM

Consideration must be given to other procedures or adjunctive treatments which were employed while attempting the relief of these patients It is a recognized fact that in cases of endocrine imbalance of this type any form of cervical instrumentation may be sufficient to tip the hormonal balance to normal Frequently, normal ovulatory cycles succeed previous irregularity, or pregnancy occurs following a period of infertility, after a simple dilatation of the internal os, a curettage, a cauterization of the cervix, or after an endometrial biopsy In one of the patients not included in this series, 4 endometrial biopsies were taken at weekly intervals before the patient could arrange for x-ray treatment, after which, ovulation promptly began Endometrial biopsy was necessarily involved in the study of all our patients, but as the large majority had been subjected to such a procedure unsuccessfully for months or even years before roentgen therapy was employed, this factor is presumably minimal

All specimens were obtained by the small suction curette according to the methods described by Klingler and Burch, Rock (21), Novak, Kurzrok, Rock and Bartlett (22), and



Fig. 3. Case 6, before treatment. Hypoplastic endometrium. Simple glands. Infrequent mitoses. Thin stroma with small nuclei.



Fig. 4. Case 6, after treatment. Secretory endometrium, twenty-sixth day. Frayed edges of glandular epithelium with basal nuclei. Absence of mitoses. Large stromal nuclei. Increasing cytoplasm. Not distending cilia.

others. The biopsies were taken as an office procedure without anesthesia or with intravenous injection of 2 to 3 cubic centimeters of cervical soluble as an analgesic. No harmful effects have been observed in hundreds of procedures. Specimens were obtained from high on either the anterior or posterior wall of the fundus uteri for here the endometrium tends to show the cyclical progression of

events best in either the normal or abnormal cycle. Biopsies were taken during the phase of possible corpus luteum activity, i.e. from 8 to 16 days before the expected onset of the next period. Failure to find secretory activity of the endometrium during this time was regarded as evidence that ovulation had not taken place and that any subsequent flowing within 10 days was anovulatory.



Fig. 5. Case 7 before treatment. Proliferative endometrium, late. Simple glands beginning to dilate. High columnar epithelium with pseudostratification and frequent mitoses. Densely packed stroma with nuclei. Extra sections of erythrocytes.



Fig. 6. Case 7 after treatment. Biopsy specimen of secretory endometrium removed on twenty-first day. Uniformly basal glandular nuclei with accumulation of cytoplasm and absence of keratin. Marked generalized edema of stroma.

CASE 8 Mrs C, FHW 125/33, a 19 year old American housewife, complained of sterility for 6 months. Until marriage, catamenia had occurred regularly every 28 days, but since then, only once every 2 months. A biopsy taken before treatment showed only endometrial proliferation.

A dosage of 360 r's was given over the ovaries and pituitary. Four weeks later a biopsy showed an 18 day secretory endometrium. Flow commenced 6 days after this biopsy and cyclical periods have been regular each month since then. The patient has not yet conceived.

CASE 9 Mrs H, 135/5, a 36 year old American housewife, complained of sterility for 8 years. There had been a 7½ months' miscarriage 15 years before and catamenia had been irregular every 2 or 3 months for 11 years. An endometrial specimen showed only hypoplasia of the endometrium.

A dosage of 360 r's was given over the ovaries and pituitary. A specimen taken at the completion of this treatment showed only hypoplasia. Catamenia became steadily less frequent. Three years after treatment the patient returned complaining of hot flushes and nervousness and was obviously entering menopause. It is unlikely that this early menopause can be attributed to her x-ray treatment, for 3 years had intervened. From the catamenial history, it would appear that there had been deficient ovarian function for some years. Roentgen therapy did not help and early menopause came 3 years later. Results from x-ray treatment may be expected certainly within a few months of the treatment.

CASE 10 Mrs C, FHW 122/276, a 33 year old American housewife, complained of sterility since the birth of her only child 8 years before admission to the clinic. Following this pregnancy, her catamenia which had previously been normal, became irregular with lengthening intervals of 4 or 6 weeks. Repeated endometrial biopsies showed hypoplasia or early proliferation of the endometrium.

A dosage of 180 r's was given over the ovaries. Catamenia remained unchanged and repeated biopsies continued to show hypoplasia of the endometrium. There have been no subsequent pregnancies and the patient would merit another course of treatment.

METORRHAGIA

CASE 11 Miss S, FHW 135/149, a 13 year old school girl, complained of menstrual difficulties since the age of 7 when she stained for a few days. She received treatment for this condition at the Children's Hospital and did not flow again until at 11 years of age. At this time cyclical flowing began and occurred at intervals of 28 days, lasting 6 or 7 days and requiring 2 or 3 napkins a day. Six months before entry to the clinic, the periods became markedly irregular, coming 1 to 5 weeks apart, with a heavy flow of about twice the previous amount. Just before entry, catamenia had continued without interruption for a month. No endometrial biopsy was obtained, but examination revealed no other abnormalities.

A dosage of 360 r's was given over the ovaries and pituitary. Flowing, which had been continuous for nearly 2½ months, stopped 1 month after the first x-ray treatment. A cycle, which was at first irregular, has occurred every 28 to 32 days for the last 2 years. Development has been normal. No endometrial biopsy was taken at any time. We have arbitrarily called this case cured in view of the dramatic change in the quality of the catamenia and the regularity of the cycles which have continued for the 3 years following x-ray treatment.

CASE 12 Miss T, FHW 120/237, an 18 year old school girl, complained that for 3 years flow had increased in duration and had become a daily occurrence for 3 months before entry to the clinic. Biopsies showed a proliferative phase only. Endocrine therapy was without effect and at the end of a year a dilatation and curettage were performed and 350 milligram hours of radium was administered through the uterine cavity. For the next year, menstruation was grossly irregular in amount, duration, and interval, the cycles varied from 2 to 5 weeks.

A dosage of 360 r's was then given over the ovaries and pituitary. A 6 day flow began 2 weeks after the first treatment and was repeated for the next year in regular cycles of from 25 to 35 days, skipping about 1 month in 4 or 5. There are no biopsies for this period.

It is debatable if this same result could not have been obtained had a second small dose of radium been given or had x-rays been used for both treatments. Actually, the same result is effected with either agent, and its selection is a matter of convenience. We have considered this case cured in view of the established cycle.

CASE 13 Mrs W, FHW 118/180, a 24 year old American housewife, complained of severe hemorrhage with periods for 2½ years following the birth of her only child. Catamenia lasted for 10 days, and exsanguination was so severe that it caused symptoms of blood loss. The patient was given 1400 milligram hours of radium after a biopsy which showed early proliferation. One week after the radium was given, flow ceased, and did not recur for 2 months when a regular 28 day cycle, lasting for 5 months, commenced. At the end of this period constant flowing again began.

A dosage of 360 r's was given over the ovaries and pituitary, and although the flowing ceased 1 week after the first treatment of this series, it started again 2 weeks later. Inasmuch as the bleeding time was found to be moderately elevated, and the patient was again anemic, a hysterectomy was performed and one ovary removed. Pathologically, nothing was found in either ovary. It is difficult to account for this picture except on the basis of the patient's elevated bleeding time which suggested a purpura-like state.

Since that time periods occurred at about 30 day intervals. This patient was treated for 3 years with hormones, but the endometrium showed only rare ovulatory cycles. An endometrial specimen on day flow started, just before x-ray treatment was given showed early proliferation and hypoplasia (Fig. 3).

A dosage of 80 r² was given over the ovaries alone. Three weeks after completion of the treatment it was thought the patient was pregnant, but an Aschheim Zondek test was negative. Biopsy was withheld for the next 2 months on suspicion of pregnancy although the patient flowed at 9 to 35 day intervals during that time. Biopsy was taken during the expected secretory phase of the third subsequent period. This showed 27 day secretory endometrium (Fig. 4). Repeated biopsies over a period of 5 months continued to show evidence of normal cyclical ovulation, with the interval down as before, 28 to 33 days, with flow lasting 5 days and the quantity as before treatment.

CASE 3 Mrs. K., FHW 27/196, 35 year old American housewife complained of sterility for 9 months. Catamenia were regular at 35 to 38 day intervals with 10 to 13 days of flow requiring a napkin daily. Biopsies throughout the next year showed both anovulatory and occasional ovulatory flowings 3 times a year. There was no regularity of ovulation, and the patient did not become pregnant.

A dosage of 360 r² was given over both ovaries and the pituitary. Catamenia began 1 month after treatment and recurred every 5 days until she became pregnant 3 months after treatment. The patient returned to the clinic after the birth of the child and was followed for the 3 ensuing years. She had had no coitus since this pregnancy and biopsies were not taken to prove constant ovulation. Catamenia, however, occurred regularly every 30 to 35 days. We consider the patient cured inasmuch as a normal pregnancy began 3 months after treatment and had not been achieved in the 3 years previous to the treatment.

CASE 4 Mrs. G. FHW 57/39, a 35 year old American housewife, complained of infrequent catamenia. She had been married for 7 years and had children, aged 5 and 5. Her periods had been normal until after her first pregnancy. Amenorrhea was constant during the 18 months in which she nursed the child and for the next 3 years flow occurred occasionally. Amenorrhea again returned for 4 years. She became pregnant at the end of this period and during the 18 months in which she nursed this child she did not have normal period. Flowing began in the twelfth month and was repeated only 3 or 4 times a year in the 4 years prior to her admission to the clinic. During this time there was a gain in weight, and hirsutism was noted, but there was no striking abnormality. The basal metabolic rate was plus 3 and plus 9, and no evidence of endocrine disturbance was found. In the next 3 months there were only 3 episodes of flowing, and repeated biopsies showed early proliferation with an 8 day endometrium. Hormone therapy as about result

A dosage of 520 r² was given over the ovaries and pituitary. Four weeks after the treatment as begun, a curettage for incomplete abortion of a pregnancy older than 2 months as necessary. The patient has refused further treatment and since then has menstruated only 3 or 4 times a year.

This is another case in which the flowing is predominantly anovulatory. Evidently the patient became pregnant in a rare ovulatory cycle and aborted as a result of the x-ray treatment. We consider this case a failure and cannot evaluate the damage to early pregnancy by x-ray dosages of this size.

CASE 5 Mrs. S., FHW 146/305, a 35 year old Russian born housewife, complained of sterility for 3 years. Menstrual cycles varied in length from 2 to 35 days. Flow lasted for 5 days and required 4 napkins a day. Endometrial biopsies taken during a year and a half showed anovulatory with occasional ovulatory cycles.

A dosage of 400 r² was given over the ovaries and pituitary. An examination, 7 weeks after treatment was completed, showed a pregnancy of 6 weeks which has come to term. A biopsy was taken.

CASE 6 Mrs. G. FHW 31/356, 35 year old American housewife complained of sterility for 4 years after an abortion in the early months of marriage. Although catamenia had been normal several years before admission to the clinic, they had become irregular occurring every 2 to 3 months thereafter lasting for 4 days and requiring 6 pads a day. In the first 6 months of study there were only 3 episodes of flowing and repeated endometrial biopsies showed hypoplasia (Fig. 3) or early proliferation.

A dosage of 360 r² was given over the ovaries and pituitary. There was no evidence of change and months later the treatment was repeated. A biopsy month after the second treatment showed trophy of the endometrium, but the patient had no symptoms of destroyed ovarian function. Flow commenced 2 weeks after the second treatment and biopsy taken 1 day before the next period, 4 months later showed 20 day secretory endometrium (Fig. 4). During the next 3 years repeated biopsies showed the 8 to 13 day cycles to be ovulatory. The patient, however, did not become pregnant.

CASE 7 Mrs. R. FHW 173/6, 35 year old American housewife, complained of sterility for 7 years. Catamenia were irregular every 2 to 13 months lasting 5 to 6 days and requiring 5 or 6 napkins a day. Biopsies of endometrium showed proliferation of 8 or 9 days, no evidence of ovulation.

A dosage of 80 r² was given over the ovaries alone. Catamenia began 5 days later and has continued in 8 to 30 day cycles for the last 3 months. We do not have an endometrial biopsy to confirm ovulation, but on the basis of her regular cycle plus moulins of menstruation, arbitrarily classed this case as cure.

CASE 8 Mrs C, FHW 125/33, a 19 year old American housewife, complained of sterility for 6 months. Until marriage, catamenia had occurred regularly every 28 days, but since then, only once every 2 months. A biopsy taken before treatment showed only endometrial proliferation.

A dosage of 360 r's was given over the ovaries and pituitary. Four weeks later a biopsy showed an 18 day secretory endometrium. Flow commenced 6 days after this biopsy and cyclical periods have been regular each month since then. The patient has not yet conceived.

CASE 9 Mrs H, 135/5, a 36 year old American housewife, complained of sterility for 8 years. There had been a 7½ months' miscarriage 15 years before and catamenia had been irregular every 2 or 3 months for 11 years. An endometrial specimen showed only hypoplasia of the endometrium.

A dosage of 360 r's was given over the ovaries and pituitary. A specimen taken at the completion of this treatment showed only hypoplasia. Catamenia became steadily less frequent. Three years after treatment the patient returned complaining of hot flushes and nervousness and was obviously entering menopause. It is unlikely that this early menopause can be attributed to her x-ray treatment, for 3 years had intervened. From the catamenial history, it would appear that there had been deficient ovarian function for some years. Roentgen therapy did not help and early menopause came 3 years later. Results from x-ray treatment may be expected certainly within a few months of the treatment.

CASE 10 Mrs C, FHW 122/276, a 33 year old American housewife, complained of sterility since the birth of her only child 8 years before admission to the clinic. Following this pregnancy, her catamenia which had previously been normal, became irregular with lengthening intervals of 4 or 6 weeks. Repeated endometrial biopsies showed hypoplasia or early proliferation of the endometrium.

A dosage of 180 r's was given over the ovaries. Catamenia remained unchanged and repeated biopsies continued to show hypoplasia of the endometrium. There have been no subsequent pregnancies and the patient would merit another course of treatment.

METORRHAGIA

CASE 11 Miss S, FHW 135/149, a 13 year old school girl, complained of menstrual difficulties since the age of 7 when she stained for a few days. She received treatment for this condition at the Children's Hospital and did not flow again until at 11 years of age. At this time cyclical flowing began and occurred at intervals of 28 days, lasting 6 or 7 days and requiring 2 or 3 napkins a day. Six months before entry to the clinic, the periods became markedly irregular, coming 1 to 5 weeks apart, with a heavy flow of about twice the previous amount. Just before entry, catamenia had continued without interruption for a month. No endometrial biopsy was obtained, but examination revealed no other abnormalities.

A dosage of 360 r's was given over the ovaries and pituitary. Flowing, which had been continuous for nearly 2½ months, stopped 1 month after the first x-ray treatment. A cycle, which was at first irregular, has occurred every 28 to 32 days for the last 2 years. Development has been normal. No endometrial biopsy was taken at any time. We have arbitrarily called this case cured in view of the dramatic change in the quality of the catamenia and the regularity of the cycles which have continued for the 3 years following x-ray treatment.

CASE 12 Miss T, FHW 120/237, an 18 year old school girl, complained that for 3 years flow had increased in duration and had become a daily occurrence for 3 months before entry to the clinic. Biopsies showed a proliferative phase only. Endocrine therapy was without effect and at the end of a year a dilatation and curettage were performed and 350 milligram hours of radium was administered through the uterine cavity. For the next year, menstruation was grossly irregular in amount, duration, and interval, the cycles varied from 2 to 5 weeks.

A dosage of 360 r's was then given over the ovaries and pituitary. A 6 day flow began 2 weeks after the first treatment and was repeated for the next year in regular cycles of from 25 to 35 days, skipping about 1 month in 4 or 5. There are no biopsies for this period.

It is debatable if this same result could not have been obtained had a second small dose of radium been given or had x-rays been used for both treatments. Actually, the same result is effected with either agent, and its selection is a matter of convenience. We have considered this case cured in view of the established cycle.

CASE 13 Mrs W, FHW 118/180, a 24 year old American housewife, complained of severe hemorrhage with periods for 2½ years following the birth of her only child. Catamenia lasted for 10 days, and exsanguination was so severe that it caused symptoms of blood loss. The patient was given 1400 milligram hours of radium after a biopsy which showed early proliferation. One week after the radium was given, flow ceased, and did not recur for 2 months when a regular 28 day cycle, lasting for 5 months, commenced. At the end of this period constant flowing again began.

A dosage of 360 r's was given over the ovaries and pituitary, and although the flowing ceased 1 week after the first treatment of this series, it started again 2 weeks later. Inasmuch as the bleeding time was found to be moderately elevated, and the patient was again anemic, a hysterectomy was performed and one ovary removed. Pathologically, nothing was found in either ovary. It is difficult to account for this picture except on the basis of the patient's elevated bleeding time which suggested a purpura-like state.

CASE 14. Mrs. C. FHW 36/66 a 30 year old American housewife complained of sterility for 3 1/2 years. Catamenia had been regular until 3 months before entry when her flowing gradually became daily occurrence. A biopsy showed early proliferation with 1 day endometrium.

A dosage of 360 r's was given over the ovaries and pituitary. Flow ceased almost immediately after the first treatment. Three days after the last treatment, the patient noted hot flushes, nervousness, and irritability which continued for a month. However flowing began again about 6 days after the last treatment and persisted at intervals throughout the next 6 months. For destruction of all ovarian activity 500 r's were then given over both ovaries.

That there is danger in roentgen therapy for patients who are elderly in reproductive life, may again be emphasized. The fact that the hot flushes were temporary and cleared up within a month suggests that the condition was due to her treatment and not to a co-incidental diminution of ovarian activity.

CASE 15. Mrs. C., 135/166, 35 year old American housewife complained of sterility for 4 months. Catamenia had always been regular until the last 3 years, when the flow lasted from 1 to 3 days an entire month and required 10 napkins a day. Biopsies showed early and late proliferation only.

A dosage of 360 r's was given over the ovaries and pituitary. Further biopsies showed no change and catamenia continued as before, until 3 years after the first x-ray treatment when a second series of 360 r's were given over the ovaries and pituitary.

Biopsies taken after this treatment revealed no improvement in the endometrium nor any evidence of ovulation. Roentgen therapy at 3 or 6 month intervals for a longer period is indicated in this case.

AMENORRHEA WITH STERILITY

CASE 6. Mrs. S. FHW 7/83, 3 year old American housewife complained of sterility for 4 years. Catamenia had always been irregular coming 1 to 2 month intervals, but had not occurred for 5 months before entry to the clinic. An endometrial biopsy showed trophy of the endometrium and on one occasion showed 1 day proliferation. Weekly endometrial biopsies failed to induce ovulation and, after year of treatment the patient was referred for roentgen therapy.

A dosage of 360 r's was given over the ovaries and pituitary. A few weeks after completion of this treatment 30 day cycles began and the patient became pregnant in 8 months. Inasmuch as the pregnancy proved ovulation, we have considered this case cured by roentgen therapy.

CASE 7. Mrs. D. FHW 5/7, 3 year old Hungarian housewife complained of sterility for 8 years. Catamenia had been regular until the birth of her only child 8 years before, but she then had oc-

curred at 4 month intervals. Repeated biopsies showed only early and late proliferation (Fig. 5).

A dosage of 360 r's was given over the ovaries and pituitary. The patient flowed 6 weeks later and an endometrial biopsy taken 6 days before that flow showed 1 day secretory endometrium (Fig. 6). At the end of 5 months, during which time catamenia occurred regularly every 4 weeks, lasted 5 or 6 days and required 3 or 4 pads a day amenorrhea again set in. We were able to demonstrate at least one ovulatory cycle ending with the first flow after roentgen therapy. There may have been infrequent ovulation in the past, but for a year before x-ray treatment we were unable to demonstrate a secretory endometrium. We have considered this case as cured by definition, though relapse occurred.

CASE 18. Mrs. L., FHW 31/263, 3 year old American housewife complained of sterility. There was a history of normal gestation 7 years before and miscarriages, the last, 3 years before entry to the clinic. Catamenia were regular at 3 to 30 day intervals until 3 months before entry when they ceased completely. A biopsy showed a 3 day proliferation.

A dosage of 360 r's was given over the ovaries and pituitary. Flow lasting 4 days began 5 days after the first x-ray treatment and continued in 30 day cycles for 4 months. Amenorrhea then recurred and lasted for 8 months. No biopsy was taken after treatment. Patient did not wish further treatment.

CASE 9. Mrs. A., FHW 2/3, a 27 year old American housewife, complained of sterility for 2 years. Catamenia had always been infrequent, having occurred no more than 10 or 12 times in all and not for 1 1/2 years preceding entry into the clinic. Endocrine therapy was employed without result for 2 years and biopsies showed proliferation in all layers, but never a secretory phase.

A dosage of 80 r's was given over the ovaries. A biopsy then showed trophy of the endometrium. There was no flowing of any sort. Five months later 360 r's over the ovaries and pituitary was given. A biopsy again showed trophy and there was no flowing. Under continued endocrine treatment with antophylin and prephylin secretory phase was shown and year later the patient became pregnant. A normal infant was delivered 1 term.

This case cannot be considered cured by roentgen therapy since pregnancy followed endocrine therapy. One may point out however that a series of x ray treatment to the ovaries and 1 to the pituitary had no effect upon the child.

CASE 20. Mrs. D. FHW 3/34, 27 year old American housewife complained of sterility and amenorrhea which had been present for the 3 years following the birth of the youngest of her children. The period had previously been regular. Repeated endometrial biopsies showed early proliferation.

Following some staining which was thought at first to be due to endocrine therapy, 1 biopsy showed necrotic decidua. The patient had surreptitiously miscarried, though there had been no evidence of ovulation during 3 years. After the miscarriage, there was no flowing for 2 months, and biopsy showed only proliferative endometrium.

A dosage of 350 r's was then administered over the ovaries and pituitary. Five weeks after treatment was started, biopsy indicated ovulation. The patient has been followed for 3 years, with frequent biopsies, and has continued to have regular ovulatory menstruation since. She was one who, before treatment, ovulated at long intervals and became pregnant during one of those cycles. Three months after a prompt abortion roentgen therapy was employed and the patient began regular ovulatory cycles which have continued for at least 3 years.

CASE 21 Mrs W, FHW 15/350, a 28 year old American housewife, complained of sterility for 10 years. Catamenia, previously scanty and infrequent, had been absent for 5 years before entry to the clinic. Biopsies showed only hypoplasia of the endometrium. A dosage of 360 r's was given over the ovaries and pituitary. Biopsies of the endometrium after treatment showed no change in the cellular pattern. This case is considered a failure.

CASE 22 Miss L, FHW 133/388, a 25 year old Italian seamstress, complained of never having had a period. There was no other evidence of endocrine dystrophy. No mucosa was obtained by repeated biopsies. Two courses of 360 r's, 3 years apart, were given over the ovaries and pituitary with no change in the picture.

STERILITY WITH NORMAL MENSTRUAL CYCLE

CASE 23 Mrs B, FHW 126/111, a 35 year old Canadian housewife, had been barren during 13 years of marriage. Catamenia were regular with a 30 day cycle, lasted 2 or 3 days and required 3 or 4 napkins a day. Repeated endometrial biopsies demonstrated progesterin effect, indicating that the patient had true ovulatory cycles with menstruation.

A dosage of 360 r's was given over the ovaries and pituitary. After treatment, given *faute de mieux*, as all demonstrable fertility factors were present, the patient developed amenorrhea with hot flushes for 7 months. She then resumed her regular cycles with ovulation, again proved by biopsy. She has never been impregnated.

CASE 4 Mrs M, FHW 150/174, a 21 year old American housewife, complained of sterility after 13½ years of marriage. Catamenia occurred every 35 or 40 days, endured for 5 days and required 5 napkins a day. Endometrial biopsy proved that these were normal ovulatory cycles. Male, as well as other female factors being found to be normal, 360 r's was given over the ovaries and pituitary, for experiment. Subsequent biopsy showed no change in the endometrial picture. The patient has not become pregnant in the 3 subsequent years.

HYPERMENORRHEA

CASE 25 Mrs C, FHW 146/355, a 31 year old Dutch housewife, complained of sterility during 8½ years of marriage. Catamenia were regular at 25 to 32 day intervals, with profuse flow, clots, and some pain. Endometrial biopsy showed questionable secretory activity. A dosage of 150 r's was given over ovaries without change in clinical picture.

CASE 26 Miss H, FHW 135/248, a 37 year old single factory worker, complained of increasingly frequent and profuse periods. Seven months prior to entry, flow had occurred every 18 days. Endometrial biopsies showed normal ovulatory cycles.

A dosage of 600 r's was given over the ovaries and pituitary. Treatment was followed by amenorrhea and hot flushes for 5 months, following which, hyperpolymenorrhea recurred and required hysterectomy. No ovarian pathology was found.

POLYMENORRHEA

CASE 27 Mrs M, FHW 126/297, a 38 year old American housewife, complained of periods which came every 18 or 19 days and required 3 pads daily. There had been 2 normal pregnancies during the last 7 years before entry. Endometrial biopsy showed regular ovulation.

A dosage of 360 r's was given over both ovaries and pituitary. There was no subsequent change in the endometrial picture, yet 2 months after the treatments, the patient began to complain of hot flushes and nervousness which have persisted for over 2 years without change.

Again we have a patient in the older age group who has suffered from a probable decrease in ovarian activity following roentgen therapy in these dosages.

RESULTS

In all, 27 cases have been reviewed. Twenty-two of these cases were of proved anovulatory flow or of flow which was predominantly anovulatory with occasional ovulatory cycles. One case, in which no endometrium was obtained on repeated efforts, is presumed to be an instance of primary pituitary deficiency. There were 5 cases of cyclical ovulation, but with associated disturbances for which roentgen therapy was employed. These last cases fell into the group which had previously been reported by the radiologists as successfully treated. The cases here reviewed fall into two groups. The first is that with absence or frequent failure of ovulation. There were 22 such cases. The second group of 5 patients includes those with normal ovulatory cycles.

but with the associated disturbances of sterility polymenorrhea, or hypermenorrhea.

TABLE I — RESULTS OF ROENTGEN THERAPY

Type of case	No. of cases	Cured		Failed		Pregnant
		No.	Per cent.	No.	Per cent.	
Absence or frequent failure of ovulation	22		24	10		
Normal ovulatory cycles but with associated sterility or abnormality of menstruation	5			5		

Of the 5 patients with normal ovulatory cycles but associated complaints, none was relieved or cured. But among the patients in group I in whom ovulation was faulty the percentage of relief or cure was good. Of these 22 patients, 12 were cured and 10 were failures.

We have necessarily chosen arbitrary standards of relief, cure or failure. Failures are those in which we could not prove an ovulatory cycle within 3 months after the completion of roentgen therapy. Cured patients are those in whom biopsies demonstrated ovulatory cycles 3 months or more after roentgen therapy, or those of sterility in which pregnancy proved ovulation, or those who acquired after treatment the menses of menstruation with periodicity of characteristic flow.

Twelve patients of the 22 treated with x rays, of predominantly anovulatory flowing, satisfy our criteria of cure. The percentage of cure is 54.5 and that of failure is 45.5. Three of the patients became pregnant or a percentage of 13.6. These figures of cure are well above the most optimistic results reported from endocrine treatment alone. In fact, an appreciable number of these cases had been through the accepted endocrine therapy before roentgen therapy was tried.

ANALYSIS OF STUDY

As was previously reported from our clinic (23) occasional anovulatory periods were detected in 9.1 per cent of 392 thoroughly studied cases of sterility. In 4 per cent of these there was evidence of habitual anovulatory menstruation. Maser, Israel and Kacher

(18) found that 30 per cent of their patients with functional sterility failed to ovulate. Various others report an incidence of from 20 to 50 per cent. In other words, this is not an uncommon condition in women whose sterility is otherwise inexplicable. Added to the distress of disturbed menstruation such a frequency emphasizes the importance of finding some means to induce ovulation.

We believe that small doses of x ray are not only not harmful, but that they also offer an appreciable promise of relief. This occurred in 54.5 per cent of our cases.

We do not postulate that any new or peculiar effect is produced by the x-ray when applied over the ovaries or the pituitary. Our findings lend support to the theory that roentgen therapy destroys one or more follicles which have matured but which have failed to rupture and progress through a normal corpus luteum phase. It is conceivable that x ray destruction of these mature follicles allows a new crop of follicles to develop normally thereafter in a majority of cases.

We do not suggest either quantitative or qualitative differences in the estrogens or in the progesterin produced before or after treatment with x ray. Our studies have not included bio-assays of the various hormones in blood and urine. We have chosen endometrial biopsy because we believe it to be a reliable index of progesterin activity and because the techniques of bio-assay are difficult, expensive and frequently inaccurate.

Partly because of Hartman's work previously referred to regarding the effect of roentgen therapy in subcastrative doses to the pituitaries of anovulatory monkeys, we feel that the essential in treatment of anovulatory flowing lies in radiation of the ovaries alone. Our latter cases have been so treated (ovaries alone) with no apparent difference between their course and the course of those with both ovarian and pituitary irradiation.

In our cases, regular ovulatory cycles began within 2 to 10 weeks following the first x-ray treatment. In the majority they began within 4 weeks. No apparent harm resulted when a subsequent series of treatments with the same dosage was given after an interval of 3 or 3 months. However this proposed roentgen

therapy should be used cautiously in cases in which the patient is 35 or more years old Ovarian function already faulty, was temporarily or completely destroyed by this small dosage of x-rays in 4 patients in this age group (Cases 14, 23, 26, and 27)

SUMMARY AND CONCLUSIONS

Twenty-seven cases of menstrual abnormality with and without associated sterility are presented The nature of flow has been evaluated by endometrial biopsy in an effort to determine whether flowing has been of the ovulatory or of the anovulatory type Subcastrative dosages of x-ray have been employed in an effort to re-establish the normal balance of ovarian function Endometrial specimens taken before and after x-ray treatment have been used in estimating the value of x-ray treatment to produce ovulation in those patients who do not ovulate or who have only occasional ovulatory cycles No harmful effects from this treatment upon subsequent pregnancies have been found in the literature

Our results indicate that the use of subcastrative doses of roentgen rays is more effective than is the present endocrine treatment Of the 22 cases of anovulatory flowing, or of infrequent ovulatory cycles, 12 or 54.5 per cent, had 3 or more ovulatory cycles following treatment In 3 of these patients, or 13.6 per cent, pregnancy occurred within a short time following treatment

We have found, contrary to the experience of other investigators, no change after this dosage of x-ray in 5 patients with previous normal ovulatory cycles who had the associated complaints of sterility, dysmenorrhea, profuse menstruation, or too frequent menstruation We believe that x-ray treatment is indicated only when there is present definite ovarian dysfunction, specifically in those patients who habitually fail to ovulate, as shown by the absence of progestin effect on the endometrium

Three doses, each of 50 to 60 r's, given over the ovaries seem harmless to the ovaries of women under 35 years of age Women older than this may suffer temporary or permanent cessation of follicular function

We are of the opinion that x-ray treatment of the pituitary offers no additional therapeutic benefit

To explain the good results we postulate a destruction by x-ray of persisting mature follicles, thus allowing a new cycle of follicle development and maturation to take place

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A ROENTGENOLOGICAL STUDY OF INTESTINAL OBSTRUCTION

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RENEWED interest in the entire subject of intestinal obstruction has been aroused since the publication of the illuminating articles and recent book by Wangensteen on this subject. He has given us a better idea of what occurs and has elucidated a new thought in the method of treatment. He emphasizes that to carry out his plan constant observation is required. In this paper we are attempting to bring out some refinements that are possible in the x-ray diagnosis of intestinal obstruction which are of considerable aid in following such cases clinically and of help in instituting proper therapy.

That an x-ray examination is of value in the diagnosis of intestinal obstruction has been known for a long time. The literature on this subject is extensive, and among the best works is that of Laurell. While well known to the roentgenologist, the aid that this procedure can give has not been fully utilized by the clinician. It should not be stated that these observations are always absolutely diagnostic but when they are considered together with the clinical symptoms we have found the x-ray findings to be of value in giving a clue as to the type of obstruction and the underlying cause. Close co-operation between the surgeon and the roentgenologist is essential so that all findings may be properly evaluated and emphasized.

The use of barium as a contrast medium to outline the gastro-intestinal tract is a well known procedure. Not as familiar to many is the fact that gas is a contrast medium and will outline the gastro-intestinal tract. It is this contrast of gas, accumulating rapidly in intestinal stasis which gives the diagnostic criterion for the study of intestinal obstruction. With the accumulation of gas is the accumula-

tion of fluid. Careful study is made of the relation of the gas and fluid in appearance, position and mobility to differentiate the type and location of the obstruction. We wish to state that in this paper we are not discussing those obstructions due to strangulation of the bowel, the result of vascular occlusion. An observation not generally appreciated is that not infrequently in a strangulated obstruction we do not find distention of the intestinal loops proximal to the obstruction either on the x-ray plate or at operation. This will be discussed in a subsequent paper.

For the purpose of this paper we divide intestinal obstruction into two types: the first is that due to a block of the free passage of gas and fluid in the bowel—the mechanical or dynamic obstruction; the other type is of neurogenic origin and is due to a stimulation of the sympathetic nervous system which is inhibitory to the bowel. In such cases there is interference with the propulsion mechanism, with a lack of peristalsis and resultant failure of transportation and absorption of intestinal contents. Wangensteen calls this inhibition ileus. It is more popularly known as paralytic or adynamic ileus. Among the causes of paralytic ileus are infection, both intra-abdominal and extra-abdominal trauma, both generalized and operative—traction on the mesentery cord lesions shock severe pain such as ureteral or gall-stone colic; and psychic factors, such as fright. We can often differentiate the paralytic distention due to intra-abdominal infection from the other larger groups.

Let us again make clear that the differentiation between dynamic, mechanical obstruction, and adynamic, paralytic, ileus, and also between the two types of paralytic ileus are not always absolute. A great difficulty is that we may have combinations of the mechanical and the paralytic. If a simple mechanical block is allowed to continue the distended

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bowel may become non-viable from the inter-luminary pressure. We will then have the same result as that of a strangulated bowel. On the other hand, a paralytic ileus caused by a localized peritonitis may cause a mechanical block by the production of fibrinous and organized adhesions. These points are emphasized in order to stress the necessity for frequent x-ray examinations during the course of intestinal obstruction and, as Wangensteen points out, this becomes particularly essential when operation is postponed and conservative medical treatment is instituted.

Both types—mechanical and paralytic—have one thing in common, namely, loops of bowel distended with gas and fluid. What is the origin of the gas? Except in infants, gas is normally found only in the stomach, duodenal bulb and colon. We can look to three sources for the gas in the bowel. Air is continually being swallowed. Normally, this is quickly broken up into small bubbles in the jejunum and carried in the intestinal contents. Gas also accumulates as a result of bacterial fermentation and there is an exchange of gas between the bowel and the circulating blood. Wangensteen believes that in the obstructed bowel swallowing of air accounts for 68 per cent of the gas, 22 per cent is due to diffusion from the blood stream and 10 per cent the result of digestive fermentation. Normally this gas is not visible in the small bowel on the x-ray films, as it is carried in solution. But as soon as stasis occurs either from a mechanical block or lack of propulsion, the gas is thrown out of solution and can be seen on the film. More gas accumulates, there is interference with absorption, so that a vicious circle is started. The gas produces distention, distention interferes with absorption, which leads to production of more gas. In addition to the gas, fluid accumulates as a result of diminished absorption and increased activity of the secretory glands. Rowntree estimates that 7000 cubic centimeters of fluid will normally reach the bowel each day. This fluid is made up of saliva, gastric juice, pancreatic juice, and succus entericus.

These two findings of gas and of fluid in the small bowel are diagnostic of an intestinal obstruction.

Before discussing the x-ray findings in intestinal obstruction let us first visualize the intestinal tract as a series of communicating loops between which there is a free movement of gas and fluid within the lumen. In any given position the fluid will tend to gravitate to the dependent parts and the gas will rise. It is this movement of gas and fluid as well as the character of the loops that we use as our criteria for the differential diagnosis between the various types of obstruction.

DYNAMIC OR MECHANICAL OBSTRUCTION

With the onset of a mechanical obstruction the bowel above dilates due to the accumulation of gas. The appearance of the bowel on the film will depend on its location. When the upper loops are distended the typical "herringbone" or "coiled spring" appearance will be present. This is due to the stretching of the circular folds or valvulae conniventes. The valvulae conniventes are reduplications of the mucous membrane, the two layers of the fold being bound together by submucous tissue. These folds are permanent and are not obliterated by distention. They run around the intestine at right angles to the long axis. When distended, the jejunum and upper ileum tend to lie in a horizontal direction one above the other and give the "stepladder" appearance. As we descend the ileum the circular folds diminish and are absent in the lower ileum. Distention of the lower ileum will have certain characteristics which will distinguish these loops from jejunum and upper ileum. Because of the absence of the valvulae conniventes the wall will be smooth in contra-distinction to the "herringbone" appearance of the upper loops. The distended loops do not lie parallel but take a vertical direction unless prevented by adhesions. The distended smooth walled vertical loops may be confused with a distended loop of sigmoid.

A short discussion of the appearance of gas in the large bowel will not be out of order because of the difficulty sometimes present of differentiating between the large and small bowel on the x-ray film. Distention of the colon will show the characteristic haustral markings and can also be recognized by its position on the abdominal film. The ascend-



Fig. 5 Anteroposterior view, 15th patient supine. Dynamic-mechanical—small bowel obstruction. B Distended small bowel, L, Proportionate fat line. Distended loops of small bowel proximal to point of obstruction.



Fig. 6 Left horizontal view. Dynamic-mechanical—small bowel obstruction. B Distended small bowel, L, proportionate fat line. Free movement of gas and fluid in the loops of small bowel. Fluid tends to lie in the same horizontal plane.

ing and descending colons lie vertically in the flanks. If doubt arises as to whether or not the distended bowel is colon, a barium enema can be safely given and the nature of the distended loop determined. The frequent taking of films will also help in distinguishing the nature of the bowel as the gas often shifts and at times the bowel will appear more characteristic than at other times. In the colon a differential point can often be made between a slowly growing obstruction and a sudden obstruction. In the slowly growing obstruction especially in the sigmoid the back pressure will dilate the cecum which may distend to the point of perforation (Saeltzer and Rhodes). Distention in a volvulus will be limited to the twisted loop which may be dilated to such a degree as to completely fill the abdomen. The distended sigmoid rises vertically starting in the midline. If allowed to continue, the volvulus will act as a mechanical block to the proximal colon.

The question arises as to whether an obstruction of the large bowel can distend the ileum. Wangenstein states that the ileocecal valve prevents the return of fluid or gas from the colon into the ileum and he makes a differential diagnosis between the small and large

bowel obstruction by absence of vomiting in the latter. This has not always been our experience. We have encountered several cases of large bowel obstruction in the colon with an incompetent ileocecal valve thus allowing distention of small intestine and vomiting of large quantities of fluid. It was noted in these cases that the patients did not exhibit the toxicity seen in small bowel obstruction and the distention was not as marked.

ROENTGEN FINDINGS IN MECHANICAL OBSTRUCTION OF SMALL BOWEL

With experience one can diagnose a mechanical obstruction of the small bowel from a single flat film. The loops of obstructed bowel are large and dark. The circular folds are prominent, giving an impression of a spring ready to uncoil. There is a marked contrast between the gas-distended bowel and the rest of the film. It has that dynamic quality of light and shade and is comparable to those paintings in which the artist uses light and shade with harsh contrasting lines to convey the impression of activity and restlessness. The coils have sharp hairpin turns and as a result of peristalsis some of the coils will be indistinct from movement during the exposure. The term dynamic is truly expressed in the appearance of this bowel. The distention involves only that part of the bowel proxi-

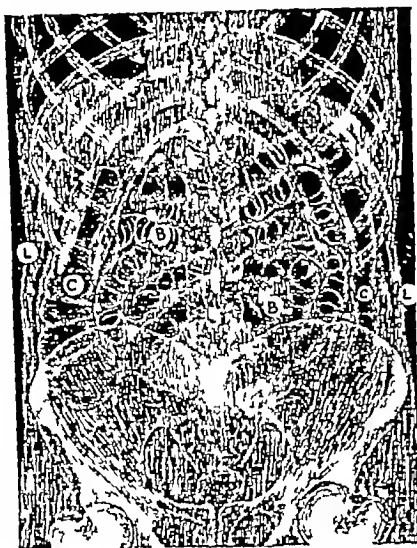


Fig 2a Anteroposterior view, supine Adynamic—paralytic, inhibition—ileus *B*, Distended small bowel, *C*, distended colon, *L*, peritoneal fat line Distention of small and large bowel

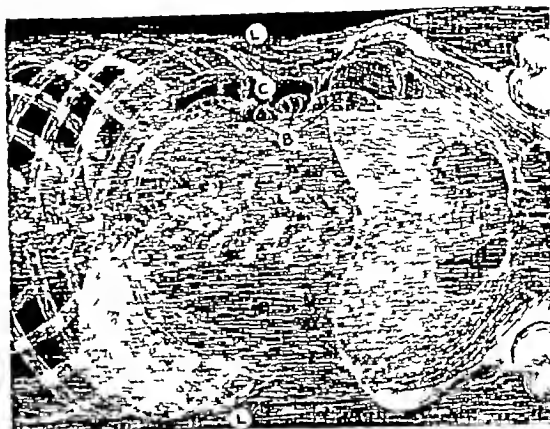


Fig 2b Left horizontal view Adynamic—paralytic, inhibition—ileus *B*, Distended loops of small bowel, *C*, distended colon, *L*, peritoneal fat line Free movement of gas and fluid in the bowel Fluid in the loops tends to lie in the same horizontal plane

mal to the point of obstruction The loops of distended bowel are large or tend to become so in future examinations

As the condition continues, fluid accumulates within the bowel There is a free movement of gas and fluid The gas tends to collect in the upper loops and the fluid gravitates to the dependent position Examination with patient in the supine position does not show the fluid present Fluid is demonstrated only by taking films with the patient upright or lying on the side and the film taken with the ray directed horizontally We call this latter position right or left side horizontal—RSH or LSH These positions allow the gas to rise above the fluid and show horizontal fluid levels Additional lower fluid levels may be seen if gas is trapped in shorter loops, but the fluid tends to lie in a horizontal plane (Fig 1)

Free fluid may be present in the peritoneal cavity This is evidenced by increased density between the loops of bowel and the absence of the peritoneal fat line

In an effort to overcome the obstruction, vigorous peristalsis is present This is evidenced on the film by change in size and shape of the gas filled bowel in subsequent examina-

tions, besides the blurred outline of some of the loops undergoing peristalsis at the time of the exposure The peristalsis also tends to cause the gas to collect in fewer and larger loops As the obstruction continues fluid increases in the lumen of the bowel, the bowel wall becomes edematous and contrast of the gas against the bowel will be less sharp As result of interluminal pressure the bowel wall may become non-viable and peristalsis cease The mechanical dynamic obstruction will then pass into a paralytic state Differentiation between the two at this point may be difficult

A mechanical obstruction of small bowel may be complete or incomplete If partial, gas may be found in different parts of the colon but never under tension When the obstruction is complete, the large bowel is comparatively free of gas, unless enemas have been given

The diaphragm moves freely in a mechanical obstruction and is limited only by the amount of the distention

To recapitulate, the x-ray findings in a mechanical obstruction are large loops of gas distended bowel, accentuated peristalsis, free movement of gas and fluid with fluid levels tending to lie on the same horizontal plane The movement of the diaphragm is limited only by the distention

ADYNAMIC OBSTRUCTION—PARALYTIC ILEUS

Röntgen findings in paralytic ileus (adynamic ileus reflex inhibition—Wangensteen) result of stimulation of sympathetic nervous system. As previously stated this condition is due to a lack of propulsion of the intestinal contents. It occurs in shock, fright, ureteral colic and gall-stone colic. In short, any severe abdominal pain which may influence the autonomic nervous system. This form of distention is what we see so often after operation. It is not due to a paralysis of the muscle but is due to stimulation of the sympathetic nervous system which is inhibitory to the muscle of the bowel. Blocking the sympathetic system by spinal anesthesia relieves the distention and peristalsis is resumed.

Too often a postoperative distention is considered a paralytic ileus, which is expected to clear up in a few days. A mechanical block may be present however and be overlooked. The difficulty of making this differential diagnosis is one of the causes of the high mortality in obstruction. It is for this type we especially make a plea for early and frequent x ray examinations. It is possible by this means to differentiate the two conditions with a fair degree of accuracy.

What diagnostic criteria have we in the x ray examination of paralytic ileus other than that due to peritonitis? First we have distention. Unlike the mechanical obstruction, in which distention is above the point of obstruction in paralytic ileus we have a segmental distention with involvement of the small and large bowel. The film in the supine position shows distention of bowel without the sharp contrasting lines. It is flat and the picture is one of rest. The condition is appropriately called adynamic. The distention is segmental. We find loops of small and loops of large bowel scattered over the abdomen. The distention may vary from the normal sized bowel to a very marked dilatation. The presence of fluid is variable. There is free movement of gas and fluid with change in position of patient. A most important clinical sign is the absence of peristalsis. While this is not a roentgenological diagnosis it is noted that subsequent examinations within the hour show little change in the relative positions of the distended loops in

this manner indicating the lack of activity of the bowel.

Paralytic ileus as a result of localized and generalized peritonitis. The appearance of this type of paralytic ileus on the x-ray film has certain characteristics which distinguish it from the paralytic ileus without peritonitis. At the beginning when the peritonitis is localized the appearance on the film may be one of a few dilated loops of bowel of an adynamic quality adjacent to the site of the peritonitis or localized abscess. If the peritonitis spreads and becomes generalized more bowel becomes distended, and the x-ray picture changes. Distended loops of bowel with gas and fluid are present and we have the picture of an adynamic ileus. In addition, with peritonitis, we may have accumulation of fluid in the abdomen. This is indicated on the film by the increase in the shadow noted between the loops of bowel.

Another more important sign may be present. This is the appearance of the peritoneal fat line. The peritoneal lining consists of a thin wall of endothelial cells. Next to this layer is a layer of fat containing some connective tissue. This fat lies between the peritoneum and muscle. It varies in thickness in different individuals. It can be seen on the film as a dark stripe in the flanks next to the bowel. With accumulation of fluid in the abdomen or edema of the peritoneal endothelial cells there is an edema of this fat layer. This brings the absorptive capacity of roentgen ray of the fat layer up to the neighboring muscle and the contrasting dark stripe is then lost. This results in a homogeneous shadow in the flank.

Care must be taken in evaluating the presence of this fat line. Its presence does not exclude peritonitis. Its absence requires study in order to be sure that the film was not overexposed. When absent it indicates fluid in the abdomen which may not necessarily be fluid from a peritonitis. As previously mentioned, fluid may be present with a mechanical obstruction and the line be lost. It is of greatest diagnostic significance when absent in only one part of the flank. If associated with a local paralytic ileus it is diagnostic of a localized abscess or localized peritonitis.

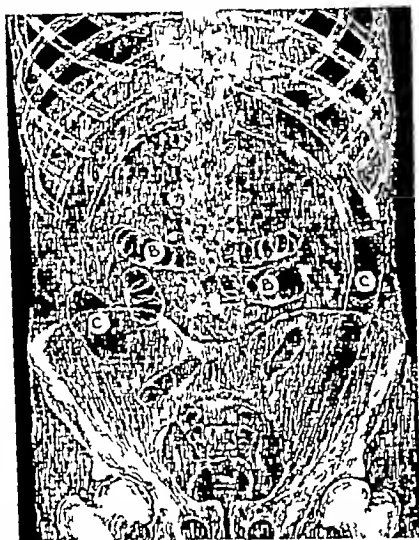


Fig 3a Anteroposterior view, supine Adynamic—paralytic—ileus as the result of generalized peritonitis B, Distended loops of small bowel, C, distended loops of colon Scattered loops of distended small and large bowel, absent properitoneal fat line

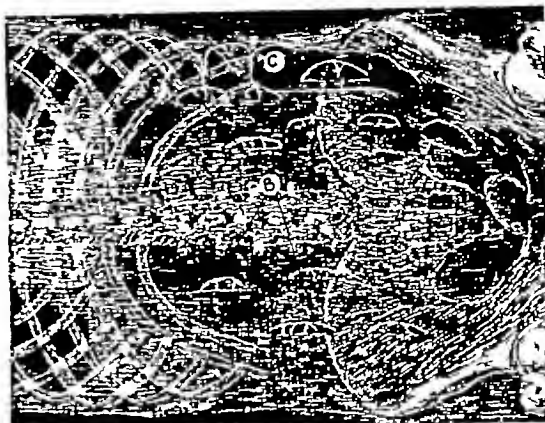


Fig 3b Left horizontal view Adynamic ileus as result of generalized peritonitis B, Distended loops of small bowel, C, distended colon Distended loops of small bowel scattered over abdomen, fixed in position resulting in multiple fluid levels Absent properitoneal fat line

Localized peritonitis The paralytic ileus present in a localized peritonitis or abscess may consist of a single loop or may involve a few loops We have not infrequently made a diagnosis of a walled off abscess by the presence of a few loops of adynamic distended bowel neighboring a region with an absent properitoneal fat line

Generalized peritonitis The appearance of the gas filled bowel on the x-ray film in generalized peritonitis also differs from that of mechanical obstruction and non-peritonitic paralytic ileus The loops of bowel as in the non-peritonitic paralytic ileus are distended with gas and contain fluid levels They are segmental in nature and loops of large bowel and loops of small bowel are equally distended That is, the distention does not extend only to the point of obstruction but is scattered Peristalsis is absent or diminished so we do not have the tendency of the small loops to gather into fewer larger loops, consequently, the loops are small and shallow If the peritoneal exudate is sticky or plastic, the loops are relatively fixed in position Turning the patient upright and to the left and right horizontal position (L S H and R S H) demonstrates the fixed

position of the loops of bowel There is no free movement of gas and fluid, consequently we have a scattering of loops with multiple fluid levels Peristalsis is absent, as it is in all paralytic ileus

There is a limitation of movement of the diaphragm which may be limited only to the side of the peritonitis (Fig 3)

To summarize, in a local peritonitis or walled off abscess there may be an ileus consisting of a single or multiple loops of bowel at the site of the infection, and obliteration of the properitoneal fat line In generalized peritonitis we have a distention of the bowel, which may involve the large as well as small bowel, of an adynamic nature, with loops scattered over the abdomen Peristalsis is absent, there is limitation of movement of the diaphragm on the affected side or on both sides if generalized The loops of distended bowel are small, shallow, and relatively fixed in position This is seen on the x-ray film by multiple fluid levels scattered over the abdomen There is no tendency toward a few large loops There is fluid between the loops and likewise there may be an obliteration of the properitoneal fat line

A word of caution should be said in interpreting the course of a case of ileus A stomach tube may be passed and suction applied The distention may be less and the patient

apparently be improved. A false sense of security is held by the clinician and the patient. It is at this point that follow up x rays are most important. The release of distention modifies the symptoms by draining the stomach and some of the fluid contents of the small bowel. The obstruction however may be unrelieved and if allowed to go on may result in a strangulated bowel. An x ray examination may show the mechanical block to be still present.

The use of the Miller Abbott tube is an additional aid both in diagnosis and treatment. In our own hands, when passage is possible within a reasonable time it has cleared up a difficult diagnosis and avoided the necessity of operation. Certain inherent dangers connected with the use of the tube which should be emphasized.

1. The difficulty in passage causes a loss of time and the delay in operation may be vital.

2. The use of the tube may relieve the symptoms without causing release of the obstruction. If a simple obstruction is present no danger results but if there is a strangulation obstruction or if the simple obstruction finally interferes with the blood supply during this period of observation vital time is lost in operative delay.

3. We have had an interesting and unusual experience in one of our own cases which is worthy of note. The tube relieved the distention and symptoms for a time but in its descent it carried some of the collapsed proximal bowel into the distended bowel and caused a small bowel intussusception.

TECHNIQUE OF THE EXAMINATION

The technique of taking the films does not involve any added discomfort to the patient. If the patient cannot be brought to the x ray department, satisfactory diagnostic films can be obtained at the bedside.

The first film is taken with patient in the supine position. These patients are uncomfortable to lie on the distended abdomen for a film in the prone position. This film gives general information as to the distention and may be sufficient to establish the diagnosis. This position does not show fluid levels. If possible a film should be taken with the patient upright.

Another film is taken with the patient lying horizontally on either side. This will show fluid levels and movement of gas and fluid. If the patient is too ill to be placed in the erect position the same information regarding free movement of gas and fluid can be obtained by the horizontal exposures with the patient lying first on the right side, and then on left side.

We have introduced the following terms and their abbreviations to designate the position of the patient and the directions for ordering special examinations for cases of bowel obstruction. The usual request for film of the abdomen in the prone, supine or upright position is standard terminology and of common usage. There is no commonly accepted term used to direct films to be taken in the antero-posterior or postero-anterior projection with the patient lying on his side. To facilitate the transmission of orders to the x ray department we suggest the term to be employed for such a view as side horizontal. This can be abbreviated S.H. As we are interested in the side uppermost rather than the side on which they lie, we can add "R." for right, which implies right side up and "L." for left.

Directions can thus be expedited and orders issued as take films of abdomen in A.P. and L.S.H. (or R.S.H.) views.

The usual film overexposes the flanks. To study the peritoneal fat line it is necessary to have soft tissue detail. Films are underexposed or a medium, as an aluminum wedge, is inserted in the space between the flank and the film to bring up the density of this part to that of the abdomen.

Just as the surgeon may not make the diagnosis of an obstruction with one examination, but may examine repeatedly so may it be necessary to have repeated x ray examinations. Obviously it is erroneous to correlate the x ray findings with a physical examination done a few hours or a day later. Just as the clinical picture changes from hour to hour so will the x-ray findings change and the clinical findings must be correlated with the x ray findings of that time.

CONCLUSION

Properly performed x-ray examination correlated with a careful history and physical

examination can be of great aid in confirming a diagnosis of intestinal obstruction. There is certain evidence found in the x-ray examination of cases of mechanical obstruction, paralytic ileus of reflex inhibition, and paralytic ileus the result of peritonitis, which if present and properly evaluated will differentiate these three conditions.

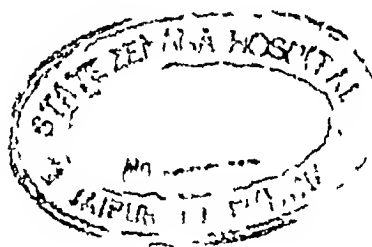
Let us make clear that the observations on intestinal obstruction which we have made in this paper are not always present or always absolutely diagnostic. But, taken together with the clinical symptoms and frequent observations on the patient, we have found them to be of great value in giving both a clue as to the type, the location, and at times even an opinion as to the underlying cause of the obstruction. We have had cases of mechanical obstruction with gangrenous bowel and negative findings on the x-ray. We have also had cases of a generalized peritonitis in which no distended loops of bowel were seen on the film. We have had cases in which fluid was present

and the peritoneal line was unchanged. We do not know why some cases have these negative findings, but when the above positive findings of gas and fluid are present, careful study of the films correlating the x-ray findings with the symptoms at the time and repeating the examination when necessary, will make it possible often to arrive at the correct diagnosis and to institute the proper therapeutic procedure.

We wish to express our thanks to Dr. Leon Goldman of the surgical department, University of California, for his criticism and suggestions in preparation of this paper and to Jean Kelso, the artist who prepared the illustrations.

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A COMPARISON OF THE FIBRINOGEN AND PROTHROMBIN LEVELS OF MATERNAL AND CORD BLOOD AT DELIVERY

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DURING a study of the so called prothrombin time of maternal and cord blood plasma (16) the fibrinogen content of each was determined simultaneously in a number of cases. The findings furnish the basis of this report. Isolated studies on fibrinogen levels under various conditions are not infrequent in the literature. Unfortunately these results are seldom comparable because of the widely differing techniques employed.

Among the earliest reports on the fibrinogen content of fetal blood is that of Krueger. The fibrinogen values of whipped blood from the fetus at the time of birth were found to be considerably lower than in the mother. The mothers gave values slightly higher than normal. Landsberg, in a more extensive study found a similar relationship between the fibrinogen values of the non-pregnant, the pregnant, and the cord blood. In 1922 Gram (8) presented the results of a new gravimetric method based on the precipitation of fibrin from physiological salt solution. During pregnancy he noted a rise in plasma fibrin well above the average which reached a peak shortly after delivery. Foster (6) in the same year confirmed Gram's work. Foster and Whipple (7) in a study of the influence of diet on blood fibrin levels, gave the normal range of plasma fibrin as 0.25 grams per cent to 0.50 grams per cent. Chandler using a micro-Kjeldahl method in place of gravimetric measurement reported on 39 cases including pregnant and non-pregnant women. The former gave high fibrin values. Kvater and his colleagues, using a salting out method reported in 1926 an increase of plasma fibrinogen during pregnancy followed by a sharp drop at the time of delivery to almost one-half the normal value.

The newborn fibrinogen levels were reported as low. Achard and his colleagues described a low total plasma protein in cord blood and suggested that this was due to a deficient globulin fraction. Naeslund employing a refractometer found the amount of plasma fibrinogen to be low in healthy children at birth. A subsequent sharp rise was exhibited during the first few weeks of life. Crane and Sanford in 1936 described the variations in fibrinogen content of the normal infant. They made 131 determinations on 10 infants over a period of 10 days. In a majority of cases the plasma fibrin content lay between 0.22 grams per cent and 0.55 grams per cent. The average for the first day was 0.39 grams per cent. They described a rise during the first 4 days of life that levelled off with no consistent change thereafter. The results of other workers generally confirm the finding of low normal fibrinogen levels in the newborn and higher than normal in pregnant women at term.

Recently a few reports on the prothrombin levels in the newborn have appeared. The results of Brinkhous, Quick (19, 20) Waddell (22, 23) Owen, and our own findings with but few exceptions, indicate that low values for cord prothrombin are the rule. Hellman and Shettles in a recent publication, suggested that prematurity is also associated with low prothrombin levels.

It was the purpose of this study to determine whether the fibrinogen values of maternal and cord blood were altered sufficiently to affect the prothrombin clotting times. A total of 18 deliveries at the Philadelphia Lying In Hospital were studied. Six healthy adult males were used for control observations.

METHODS

At the time of severing the cord, blood from the placental stump was collected directly

From the Ayer Clinical Laboratory of the Pennsylvania Hospital, Philadelphia, Pennsylvania.

into a paraffin lined beaker. Immediately a small test tube containing 0.5 cubic centimeter of 0.1 molar sodium oxalate solution (approximately 1 per cent) was filled to a 5 cubic centimeter mark with blood from the beaker, and the contents gently mixed. Shortly thereafter a similar sample was collected from an antecubital vein of the mother by means of a clean, dry syringe. The prothrombin content of each was determined after the method of Quick (18). The plasma was obtained by centrifuging for 20 minutes or more at approximately 3,000 revolutions per minute. The volume of packed red blood cells was determined simultaneously. One cubic centimeter samples of plasma were taken for fibrinogen determinations. The technique¹ was a modification of that presented by Gram (9). It consisted of diluting 1 cubic centimeter of plasma with 9 to 19 volumes of physiological salt solution in a large test tube and adding 0.1 cubic centimeter of calcium chloride solution (0.025 molar). The contents were then mixed and the tube was permitted to stand in a water bath at 37 degrees C for at least 2 hours. In most instances a watery, gelatinous clot formed which easily could be transferred in its entirety from the test tube to several layers of filter paper. The fibrin clot was then washed with physiological salt solution to remove nitrogenous contaminants. The nitrogen content was determined by the micro-Kjeldahl method as described by Koch and McMeeken. The protein content was estimated by multiplying the nitrogen figure by the factor 6.25. To determine the percentage fibrinogen of undiluted plasma a correction had to be made according to the formula of Gram (9). Observed readings for volume of packed erythrocytes were used in calculating maternal and cord blood while 46 volumes per cent was arbitrarily selected for correcting the normal controls.

RESULTS

Maternal blood plasma furnished large, firm, cohesive clots. The fibrinogen content in grams per cent ranged from 0.25 to 0.66 with an average of 0.54. The prothrombin content averaged 130 per cent of the normal controls.

¹Indebtedness is expressed to Dr. Leandro M. Tocantins for suggesting this method.

Cord plasma as a rule furnished delicate, loose, friable watery clots. In 2 instances no clots at all were perceptible. This occurrence was found to be associated with an excessive dilution with saline (19 volumes) rather than a deficiency of fibrinogen or prothrombin. The fibrinogen values varied between 0.23 and 0.49 grams per cent with a mean of 0.33. The prothrombin content averaged 68 per cent of the normal controls.

Adult male plasma formed clots that resembled those of maternal plasma yet failed to duplicate the dense tough character of the latter. The fibrinogen content varied from 0.22 to 0.33 grams per cent with a mean of 0.275. As this plasma was used as normal prothrombin control material, the prothrombin content was taken to be 100 per cent.

EVALUATION

Eagle and Quick (21) describe the effect of varying concentrations of fibrinogen on the clotting time. They conclude that, except in extremely low ranges of fibrinogen, the clotting time of plasma is unaffected. This conclusion is borne out by our findings. Comparing the fibrinogen and prothrombin values of infants with normal adult males, one sees that with nearly identical fibrinogen levels there are widely differing prothrombin clotting times, the infants are significantly below normal in the latter respect. On the other hand, on comparing the plasma from mother's blood with that of normal males, one sees an increase in the fibrinogen content associated with an acceleration of the prothrombin clotting time above normal. With these findings in view, it becomes difficult to attribute to the fibrinogen content of the plasma any significant influence on the prothrombin value. However, it is interesting to speculate whether the frequent association of low prothrombin in the presence of normal fibrinogen levels represents a developmental weakness in liver function or a vitamin deficiency.

SUMMARY

1. The plasma fibrinogen and prothrombin levels of 18 samples of maternal and cord blood taken at the time of delivery are compared to the values of 6 normal individuals.

2 The fibrinogen content of plasma of cord blood is normal but the prothrombin content is reduced.

3 Fibrinogen and prothrombin contents of maternal blood at the time of delivery are above normal

4. The prolonged prothrombin clotting time of cord blood is not due to a deficiency of the plasma fibrinogen.

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EFFECTS OF EXPERIMENTAL CHRONIC HYPERPARATHYROIDISM ON THE KIDNEY OF THE DOG

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AFTER the discovery of the parathyroid glands by Ivor Sandstrom in 1880, no attention was paid to them until their rediscovery by Gley in 1891, Moussu, in 1897, and later Halsted demonstrated the functional independence of the parathyroid gland and the thyroid. Because extracts of the gland were not available at that time, an erroneous hypothesis was developed as to the action of the parathyroid glands. Although various types of bone lesions were described by earlier investigators, the first anatomical descriptions of such lesions in parathyroid overfunction were ascribed to Stansky by Lievre. It was Askanazy and Lundborg, in 1904, and Chvostek, in 1908, who paved the way for an early understanding of the parathyroid glands and their relationship to bone lesions.

It was not until 1905, however, that MacCallum associated the parathyroid glands with renal disease, and showed the coexistence of tumors of the parathyroids with pathological changes in the kidney. Barker mentions a case studied by Thomas and Wentworth in which parathyroid hyperplasia was associated with chronic renal disease of 10 years' standing. In this patient deposits of calcium were present in other parts of the body, and the x-ray showed calcification of smaller arterioles. At autopsy bone changes were present. Bergstrand described hyperplastic enlargement of the parathyroid glands in 10 cases of severe renal disease. None of these patients showed osteoporosis or osteomalacia but did show deposits of calcium salts in the kidney.

The entire subject of hyperparathyroidism has now been thoroughly investigated by numerous workers, both clinically and experimentally. The work of Mandl, in 1926, and of Hannon, Shorr, McClellan and DuBois, in 1930, showed the relationship between over-

function of the parathyroid gland and osteitis fibrosa cystica, and in 1934 the work of Albright, Aub and Bauer definitely pointed out that there were other clinical forms of hyperparathyroidism which presented symptoms in common with other disease entities often giving no signs related to bone disturbances, namely renal stones. In their series of 17 cases of hyperparathyroidism proved by operation and removal of parathyroid tumors there were 7 patients who had only symptoms of stone, 1 with only symptoms of a nephritis, and 10 who had symptoms referable to the genitourinary tract. Routine calcium phosphorus studies in all patients with stone revealed 8 to have parathyroid tumors. In a later report, in 1935, Albright and Bloomberg (2) reported a series of 23 cases of hyperparathyroidism. Eleven patients with renal stone were proved at operation to have parathyroid tumors. These patients had no bone lesions or symptoms. Only 5 of 23 patients had bone lesions or symptoms without renal disease.

Castleman and Mallory, in 1935, reported that, in patients with hyperparathyroidism associated with stone, symptoms had lasted for an average of 3.2 years and when bone lesions were present the symptoms had lasted for an average of 8.6 years. Elsom, Wood, and Ravdin, in 1936, reported a case of hyperparathyroidism with renal insufficiency. Their case presented signs of osteitis fibrosa cystica with diffuse calcifications of the kidneys. A tumor of the parathyroid gland was found at operation. The disease in this patient escaped detection for some time because it was thought that her symptoms arose from an atypical form of glomerulonephritis.

It is interesting, however, to note the various theories for the formation of stone in the kidney. Randall in his extensive investigation as to the origin of primary renal calculi, suggests that one of the causes for such stones might be attributed to parathyroid overfunc-

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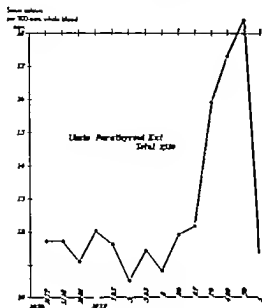


Fig. Dog 97

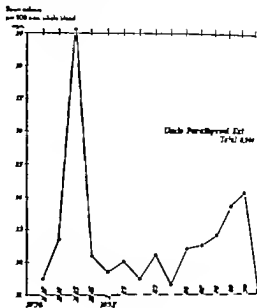


Fig. 2. Dog 103.

tion. The author has attempted to produce experimentally a condition of hyperparathyroidism in normal adult dogs by means of injecting them subcutaneously with parathormone.¹

It was considered advisable to conduct a long continued experiment in which conditions might resemble more closely those to be expected in clinical cases of hyperfunction of the parathyroid gland.

Kindly supplied by E. H. Lilly & Co.

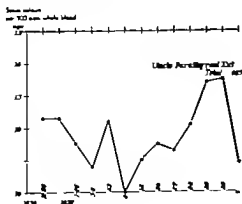


Fig. 3. Dog 5.

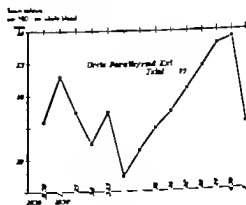


Fig. 4. Dog 3.

METHODS OF STUDY

Adult dogs were used in these experiments because of the probability that older dogs would show similarities in changes produced by an overfunction of the parathyroid glands as seen in human clinical cases (14). The exact ages of the dogs were not known because the animals were obtained from a dog farm where they were collected from several sources. The diet was well balanced and simulated one which any human might follow. Water was

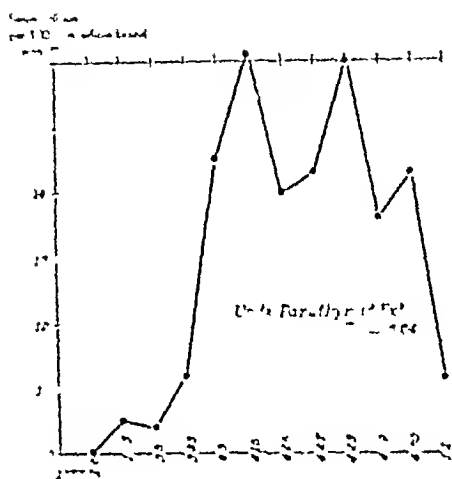


Fig 5 Dog 315

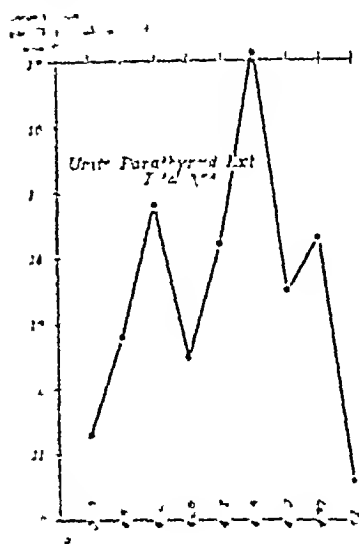


Fig 6 Dog 523

kept in the cages at all times. Two groups of 15 and 16 dogs respectively were used one being a control upon the other. The experiments were carried on in two parts. The first was started on November 17, 1936 and ended May 1, 1937 a total of 6 months, and the second experiment from September 23, 1937,

to May 4, 1938 a total of 8 months. Parathormone was used throughout the entire research. The animals received varying doses of parathormone injected subcutaneously. The dose depended on the tolerance of the dog to the hormone. At first the dose was 100 units daily, which was calculated according to the weight of the animal. However the dose was too large, and as a result many of the animals became sick and several of them died. It was

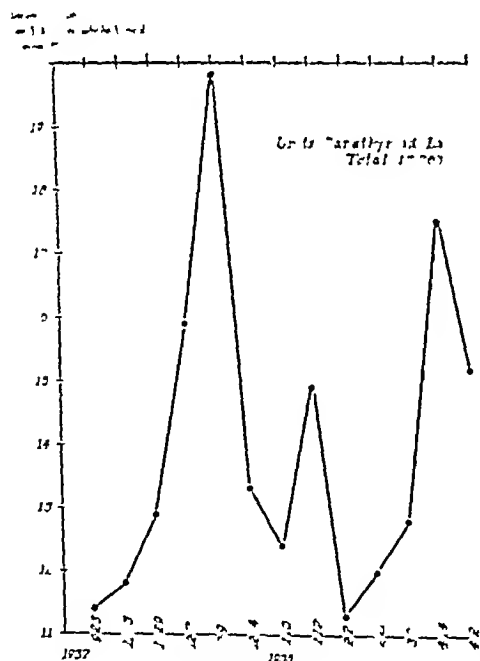


Fig 7 Dog 43

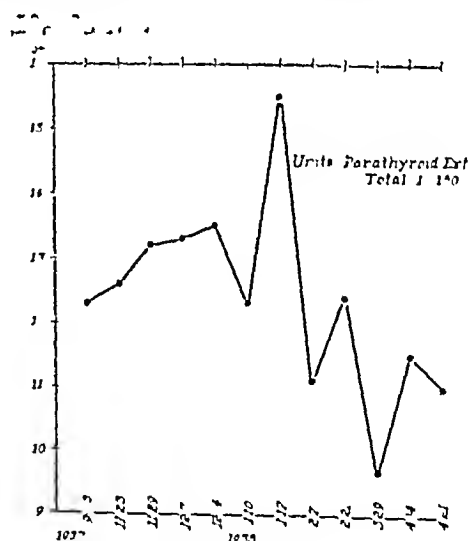


Fig 8 Dog 45

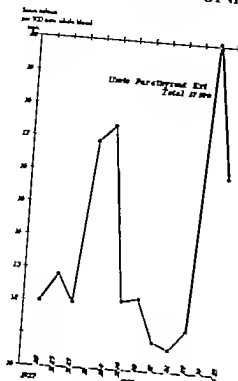


Fig. 9. Dog 47

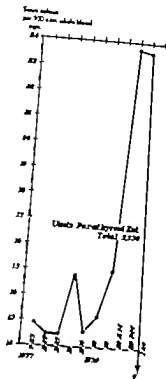


Fig. 10. Dog 66.

therefore necessary to employ the highest possible dose that would not make them sick or die. The best dose was found to be 5 units daily, increasing it to 20 units after several days, and then gradually increasing the dose at frequent intervals so that by the time the animals were ready to be sacrificed they were receiving a dosage of as high as 600 units of parathormone daily. Rest periods from the hormone were given whenever it was thought necessary. Serum calcium estimations were taken at frequent intervals although at times this was difficult because the blood coagulated so rapidly. Viosterol was added to the diet of several of the dogs as suggested by Johnson. Other mineral studies were not attempted since much work has been done experimentally by other investigators (5, 6, 15, 23).

In several instances roentgenograms were obtained during the course of the experiment to note any renal changes. In the first group of dogs nephrectomies were done to note

Supplied by Mead Johnson & Co.

whether the effect of parathormone was greater on the remaining kidney.

When the animals died or were sacrificed the organs were carefully examined grossly and microscopically. The urogenital organs were examined minutely for calcifications especially the papilla of the kidney which was examined for calcium plaques described by Randall (30). The tissues removed for section were imbedded and blocked in paraffin. The stains used were the VonKossa, alizarin, Hansen-Bach, and the modified Schultz technique for clearing. The whole kidney of dogs 148, 163, 43, 45 and 47 was cleared by the modified Schultz method and stained with alizarin, which is a specific for calcium (this technique is the one followed by the Wistar Institute of Anatomy in preparing skeletons of rats) and the opposite kidney was sectioned.

The parathyroids in some of the animals were fixed for section as were specimens of bone taken from the forelegs of the animals.

TABLE I.—SERUM CALCIUM DETERMINATIONS

Drug No.	87	98	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	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TABLE II
SECURITY RISK TOLERANCES

[illegible]

Signature _____

13 (Cont'd, page 2) 14

[illegible]

16; Did I take a wrong turn? I only was confused a little.

... ..



Fig. 3. Bladder of dog, showing collection of calcium.

ceived almost three times as much parathormone did not have such an increase in their serum calcium unless they may have developed a tolerance (29). Other explanations offered are the age of the animal, an increased rate of excretion of calcium, or the hypercalcemia was counteracted by feeding (22, 35) as, for

example, in dog 45 with a total of 18,180 units of parathormone and in dog 163 with a total of 17,930 units of parathormone the serum calcium rose only to 15.5 milligrams per cent and 12.9 milligrams per cent, respectively.

A point of interest was the drop in serum calcium of all dogs, after rest periods, below the level of their normal serum calcium. Other investigators have reported similar observations (14) and interpreted the drop as being due to a reduction in the calcium reserve of the tissues, especially the bone. When parathormone injections are discontinued, the calcium is reabsorbed into the bone at such a rate that hypocalcemia results. This has been proved histologically and clinically (21, 29).

The dogs in which nephrectomies were performed showed no demonstrable change in the remaining kidney, as compared with the dogs in which no nephrectomies were done.

Röntgenographic studies on several of the animals, including intravenous urograms, were negative for bone lesions or nephrolithiasis. Greenwald and Gross (14) reported similar observations.

PATHOLOGY

Of greatest interest to the author were the findings at autopsy, especially the urogenital findings. Dogs 103, 125, and 131 had stones in the bladder (Fig. 13); the chemical analysis



Fig. 4

Fig. 14. Photomicrograph of section of kidney of dog. There can be seen cloudy swelling and tubular degeneration. Intratubular deposits of calcium are also present. $\times 45$.

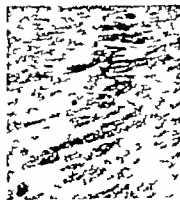


Fig. 5

Fig. 5. Photomicrograph of dog kidney showing

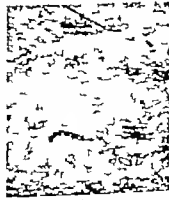


Fig. 6

deposits of intratubular calcium and tubular atrophy. $\times 45$.

Fig. 16. Photomicrograph of kidney of dog, showing cloudy swelling, glomerular degeneration, and deposits of intratubular calcium. $\times 15$.

of which proved them to be composed of calcium phosphate. The following observations, except for insignificant differences, are applicable to all the animals subjected to autopsy. There was marked hyperemia throughout the omentum and abdominal viscera. The kidneys were markedly congested with grayish striations throughout. The papillae were hyperemic, and several of them showed to the naked eye what appeared as gray plaques somewhat similar to those found at autopsy of the human papillae (30, 31, 32). No stones were present in the pelvis of the kidney nor on the papillae of the kidney. The ureters were normal and contained no stones. The observations of the microscopic section are reported here as representative of all the dogs seen in Tables I and II which showed calcium to be present. They are as follows. The sections showed cloudy swelling to be present. There was marked shedding of the tubular epithelium in some places. Also, sections of the tubules, in which some of the cells were partly detached, contained varying amounts of calcium deposits forming solid dark blue casts, a greater quantity being in the detached and most abnormal cells. There were also necrotic cells present in some of the tubules. In another section the tubules presented a peculiar appearance showing evidence of having undergone atrophic changes. This might be explained as being a



Fig 17 Kidney of dog cleared by modified Schultze method and stained with alizarin, a specific stain for calcium. The calcium deposits throughout the entire kidney are clearly shown in the darker areas. $\times 17$

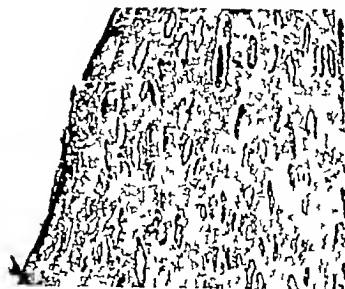


Fig 18

Fig 18 Photomicrograph of kidney of dog, showing calcium plaque on the side of a papilla. This is the second time that such a lesion has been observed in a lower animal. $\times 35$



Fig 19

Fig 19 Photomicrograph of a section removed from the kidney of a dog. This section shows tubular degenera-



Fig 20

tion, cloudy swelling, and degeneration of the glomerular tufts. $\times 60$

Fig 20 Photomicrograph of section of kidney of dog, showing cloudy swelling, tubular degeneration, and calcification of Bowman's capsule, with glomerular tuft lying free in space. $\times 75$



Fig. 3. Bladder of dog, showing collection of calculi.

ceived almost three times as much parathormone did not have such an increase in their serum calcium unless they may have developed a tolerance (29). Other explanations offered are the age of the animal, an increased rate of excretion of calcium, or the hypercalcemia was counteracted by feeding (22-35) as for

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PATHOLOGY

Of greatest interest to the author were the findings at autopsy especially the urogenital findings. Dogs 103, 125 and 131 had stones in the bladder (Fig. 13) the chemical analysis



Fig. 14

Fig. 14. Photomicrograph of section of kidney of dog. There can be seen cloudy swelling and tubular degeneration. Intratubular deposits of calcium are also present. $\times 45$.



Fig. 5

Fig. 5. Photomicrograph of dog's kidney showing

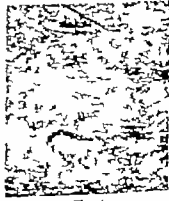


Fig. 6

deposits of intratubular calcium and tubular atrophy. $\times 45$.

Fig. 6. Photomicrograph of kidney of dog, showing cloudy swelling, glomerular degeneration, and deposits of intratubular calcium. $\times 45$.

precursor of tubular destruction before calcium is deposited (Figs. 14, 15, 16)

An interesting observation and the second time ever reported is the formation of a calcium plaque on the side of a papilla (Fig. 18). This occurred twice in 31 dogs under study (Dog 97 reported in an earlier paper (3) and dog 294.)

The capillaries in the glomeruli were hyperemic, and hemorrhages throughout the sections were observed. Round cell infiltrations commonly were seen. The glomerular tuft appeared to be detached and shrunken, lying free in the glomerular space and Bowman's capsule were calcified (Figs. 19 and 20)

One of the kidneys of each of dogs 43, 45, 47, 163 and 148 in the second group instead of being sectioned, was fixed and cleared by the modified Schultz method and stained with alizarin. Figure 17 clearly demonstrates the heavy calcium deposits throughout the entire kidney resembling a roentgenogram frequently observed in cases of nephrocalcinosis. I believe that this method of staining for calcium might be a more sensitive test than is the one usually followed.

SUMMARY

1. Thirty-one dogs were injected with parathormone subcutaneously to produce experimental hyperparathyroidism

2. Viosterol was added in gradually increasing doses to the diets of 20 of these dogs, and exerted no observable change over those to which no viosterol was given.

3. The rise and fall of the serum calcium in all of the animals is in accord with the findings in similar experiments by others.

4. No bone changes were demonstrable in any of the dogs.

5. Vesical stone was present upon 3 occasions.

6. At autopsy the following were noticed (a) oriental and gastric hemorrhage (b) visceral engorgement and (c) marked renal damage

7. Calcium plaques described by Randall were present in 2 dogs

8. Almost all of the dogs showed deposits of intratubular calcium microscopically

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T. Dr. I. S. R. and Dr. A. Randall I wish to express my sincere gratitude for their suggestions and help in this work.

CLINICAL SURGERY

FROM THE JAMES BUCHANAN BRADY UROLOGICAL INSTITUTE

RADICAL PERINEAL PROSTATECTOMY

Modification of Closure

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THE rare occurrence of shock, visual control of hemorrhage, and dependent drainage with the bladder completely at rest are definite indications for perineal removal of the enlarged prostate in many cases. One of the most important indications for perineal exposure and treatment of the prostate is the presence of early carcinoma. In certain cases of carcinoma of the prostate the lesion is confined within the capsule and fascias of the gland thus making the situation favorable for complete removal and cure of an otherwise surely fatal condition. The origin and development of the radical perineal operation for prostatic carcinoma by Young has been the only hope of cure in carcinoma of the prostate. The results of such operations in this clinic, in which many patients have been cured and are living and well today, can be found in the publications by Young. If the operation is carried out according to the accepted principles, the average case does not present unusual technical difficulties, especially when the carcinoma is confined within the capsule and is not accompanied by considerable benign enlargement.

Certain cases are encountered, however, in which there is either considerable benign enlargement or else extension of the carcinoma toward the apex of the gland so as actually to invade the beginning of the membranous urethra. When the latter has occurred, more extensive removal of the prostate is necessary and, in order to effect a complete cure, it is necessary to remove a portion of the external sphincter, which sometimes results in incontinence. Such a more extensive removal of the membranous urethra has at times presented difficulties concerning anastomosis of the bladder with the membranous urethra and triangular ligament. This has usually been carried out by means of sutures between the cut margin of the bladder to include the triangular ligament. These sutures

have included the muscle mass which comprises the external sphincter. It occurred to the writer that such sutures which hold the bladder margin against the triangular ligament must pass through some portion of the external sphincter and when tied sufficiently tight to hold the bladder firmly in approximation they must ligate a portion of the sphincter. It is possible that this partial ligation of the external sphincter might account for the resulting weakness in some cases and especially even in cases in which no part of the sphincter has been deliberately excised or injured. For this reason the writer has devised the so called "traction sutures" shown in Figure 1.

TECHNIQUE

The complete technique of removal has been described by Young and need not be reiterated here. Figure 2 shows the terminal views of the operation in which the apex of the prostate has been divided and the entire prostate freed, with complete separation at the vesical orifice. In this figure the trigone is being pushed backward from the seminal vesicles and their enveloping fascia, separating them from the base of the bladder. It also shows the division and ligation of the fascia and attachments at the tips of the seminal vesicles just before removal of the prostate, its enveloping fascia, and seminal vesicles *in toto*.

Section 1 of Figure 1 shows the perineal view of the open bladder after complete removal of the prostate, its fascias, the seminal vesicles, ampullæ, and distal vasa, for carcinoma of the prostate. The opening into the triangular ligament which comprises the urethra can be seen. The trigone and ureteral orifices are visible just behind the divided posterior lip of the bladder. Three traction sutures labeled 1, 2, and 3, which have been placed in correct positions, are shown in this view. The first suture has included the anterior

Laboratory fellow in Urology

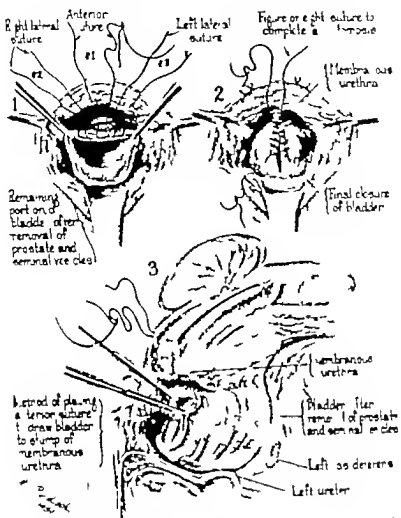


Fig. Technique of traction sutures to avoid injury to external sphincter following radical perineal prostatectomy

margin of the bladder in the midline by means of a firm bite so that the sutures emerge just at the margin of the bladder mucous membrane. This, 1, or anterior suture, after leaving the bladder margin transverse the external sphincter on either side of the urethra just beneath the mucosa. It continues just beneath the mucosa through the external sphincter area on through the triangular ligament and through a portion of the bulb of the urethra perineal fat and subcutaneous tissue so that it finally emerges on either side of the midline just beneath the skin at the anterior margin of the perineal incision. A sagittal view of this suture is easily seen in Section 3. It can be

readily understood how traction on this suture will pull the anterior margin of the bladder from deep in the wound into true approximation to the cut margin of the membranous urethra. This is merely a straight pull through the area of the external sphincter and in no way ligates, constricts, or interferes with the function of this muscle as is conceivable heretofore by the use of conventional sutures. In Section 1 of Figure 1 two additional sutures designated 2 and 3 are placed well to the side of the midline and carried just beneath the mucosa to each lateral side of the membranous urethra and through the sphincter being brought out through the perineum at the margin of the

skin incision well to each side of suture 1. When traction is made on these three sutures and they are tied, considerable circumference of the cut bladder margin is drawn tightly against the membranous urethra and anchored there without any interference or constriction of the sphincter muscle in this area. The lateral sutures are usually tied first and then a strand of the anterior suture is tied to each of the lateral sutures so that there is no constriction across the midline. No 2 chromic catgut is used so that the bladder is anchored in position until thorough healing of the divided mucous membrane can take place. It is more convenient to place these sutures with a urethral catheter emerging from the opening end of the membranous urethra, but the catheter has been omitted in these illustrations in order that a more clear idea of this suture principle can be obtained. Following the above procedure closure of the remaining open bladder is carried out as shown in Section 2 of Figure 1. When this final suture is completed to close the bladder opening there is usually a small opening at the point of anastomosis because the three traction sutures include only three-fourths of the circumference of the membranous urethra. A simple figure-of-eight suture carried in a very shallow manner into the triangular ligament and mucous membrane at this point is then placed to complete closure as is shown in Section 2. Complete closure is carried out over a moderate size urethral catheter in place to insure adequate drainage. The perineal wound is then easily and quickly closed in the usual manner with two small Penrose drains from each angle to insure drainage of extravascular tissues.

The writer has used the above traction sutures in only 4 cases but with entirely satisfactory results in each. The method is presented purely for what it is worth in the hopes that it will eliminate additional trauma to the muscles of the external sphincter following such a valuable procedure as total prostatectomy to cure carcinoma of the prostate.

SUMMARY

Certain cases of carcinoma of the prostate are confined within the capsule and fascias of the gland resulting in a favorable condition for radical removal and cure of an otherwise surely fatal disease. Statistics show an apparent cure in over 50 per cent of the cases followed over 5 years after Young's radical operation. The average case does not present unusual technical difficulties. In some instances it is necessary partially to excise and thus to injure the area of the tri-

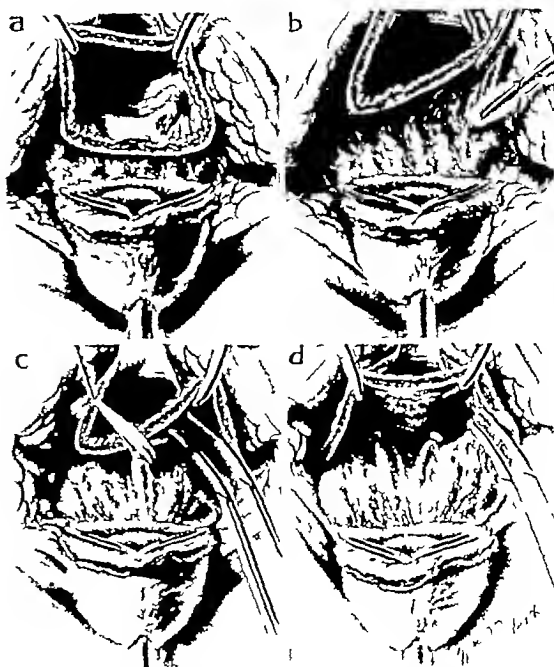


Fig 2 Removal of entire prostate confined within its capsule, and also of seminal vesicles. a, Trigone has been divided and, b, bladder is being stripped up from vesicles and vasa, which are being ligated in c. d, Vasa have been divided and ligated, and fascial attachments of seminal vesicles are being divided, following which prostate, seminal vesicles, and terminal vasa are removed *in toto*.

angular ligament comprising the external sphincter, this leads to incontinence. In other instances the sphincter is injured by ligation as a result of conventional sutures which are used to approximate the bladder margins to the membranous urethra.

The introduction of "traction sutures" to approximate the bladder to the membranous urethra following radical removal of the prostate for carcinoma has been presented here. These sutures pull the bladder firmly against the triangular ligament without any ligation of the musculature comprising the external sphincter and in this way minimize the chances of injury to this muscle with resulting weakness and partial incontinence. This procedure has been found valuable to the author in 4 cases, and it is believed that it deserves wider use.

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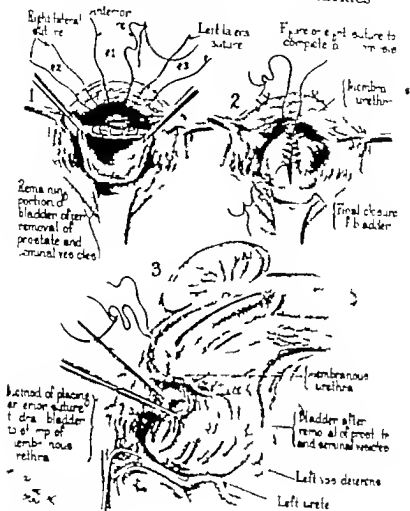


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BRACHIOTHORACIC ADHESIONS

JOHN F. BURTON, M.D., F.A.C.S., Oklahoma City, Oklahoma

BRACHIOTHORACIC lesions although not common are constantly occurring and in almost any general hospital one or two cases a year may be seen. Since they are infrequent, the surgical attendant as a rule is not thoroughly familiar with a plan of treatment and directs his efforts along lines of general surgical principles. While doing this he not only is defeating his purpose but is allowing a vicious condition to develop that will increase the work to be done if not permanently injure the patient. In specialized institutions too where such deformities may be referred for treatment, there has not always been unanimity of opinion as to how such cases should be managed. In recent years, the works of De Zs, Koch and Blair and Brown have served to stimulate thought and discussion of the subject.

We may define brachiothoracic adhesions as any abnormal surface attachment between the arm and chest wall. It may be a congenital deformity or it may be the result of violent traumatic injury or of an extensive inflammatory condition. It may follow an operative procedure involving the area or it may ensue from a severe burn. The latter is the most common cause.

The condition assumes importance out of proportion to its appearance. In the majority of cases the arm is practically incapacitated, the growth and development of the entire upper extremity and, in marked cases, the growth of the mamma and structures of the chest wall are affected.

When a study of the production of such adhesions is made consideration should be given first to the anatomy involved. Anteriorly and medially the pectoral and subclavius muscles exert a pull upon the arm that is directed toward the body. Posteriorly and medially the same action is performed by the *teres minor*, *teres major* and *latissimus dorsi* muscles. Between these two groups of muscles and between the chest wall and the arm lie the superficial and the deep fascia with the combined fascia of the apex forming the *costa coracoid* membrane. Second, familiarity with the pathological manifestations in the structures involved should be acquired. The loss of epithelium and its failure

to regenerate completely over the arm, axilla, or chest wall, is the primary pathological process.

To repair this, there are two separate actions upon the part of the body: first, the adduction of the arm thus protecting the important axillary structures and at the same time decreasing the amount of unepithelialized surface; second, the uniting of tissue as the granulation tissue surfaces come into contact with each other. Gradually the thinned become more organized, more fibrous, and finally a dense hard contracting web scar is formed.

With this understanding of conditions in mind, we approach the treatment of the patient.

First, the prophylactic phase should be discussed since it would seem from experience that this has been wrongly emphasized. In the medical journals and the surgical textbooks, many authorities advocate splinting, casts, and appliances to prevent the development of adhesions. When I started caring for patients with these adhesions I followed along such precepts. However as I daily watched their suffering as I saw contractures develop before my eyes, in spite of the splinting as I followed patients in the out-patient department and observed the contractures increase, or develop in cases in which healing had taken place and in which patients at first appeared not to have an appreciable deformity and finally as I operated upon such patients and demonstrated grossly and microscopically the amount and extent of scar tissue, I became convinced that this method of treatment was not the one most satisfactory (Figs. 1 & 3). The more I watched these patients, the more it became apparent that our efforts were misdirected. It is a fundamental principle of surgery that living tissue responds to injury in a well proved definite manner. There is first a cellular exudate, the formation of a fibinous framework, and soon among the cellular elements fibroblasts appear and effect the repair needed. Now if the part is continually irritated that is by stretching or splinting or by repeated painful dressings, there will be a greater production of fibrous tissue. As this fibrous tissue becomes more organized it shrinks and thereby causes contractures. This ultimate result may not show its maximum effect until perhaps 6 months after healing has taken place (Figs. 4 and 5).

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Fig 1

Fig 2

Figs 1 and 2 Case No 72041 Extensive infected burn with ulceration of neck, anterior chest, shoulder, arm, and left axilla. The parts are held apart with a plaster reinforced cast in as near the position of function as possible to maintain them. The patient required large doses of



Fig 3

sedatives, the ulcerations showed very little signs of healing and it was impossible to eradicate the infection entirely.

Fig 3 Case No 72041 Result obtained by removing cast, applying moist saline packs and later application of skin grafts.

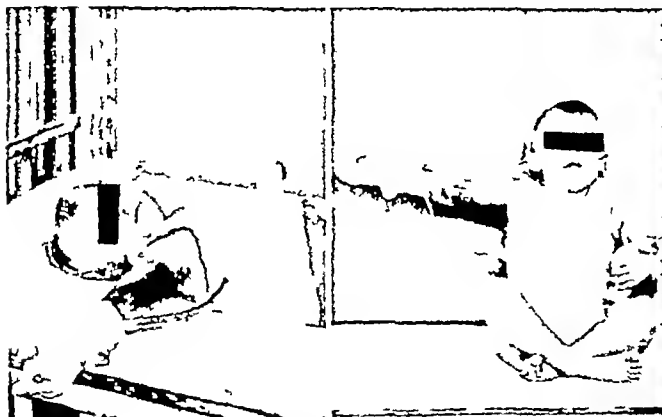


Fig 4

Fig 4. Case No 373 Splinting may be used cautiously with children but should be of short duration and provide easy access for dressings.



Fig 5

Fig 5 Case No 373 Grade I contracture of axilla and cord across cubital fossa. Treated early with grafts but shows effect of irritation by stretching resulting from cast.



Fig 6 Case No 66913 Ideal position and care for prevention of axillary adhesions.



Fig 7, left Case No 66913 Result 4 months after Figure 6, not yet completely healed.

Fig 8 Same case Result 1 year later with Grade I contracture of left axilla. This patient had no splinting at any time.



Fig. 9

Fig. 10

Fig. 9. Case No. 94350. Patient suffered an axillary adhesion following burns years ago. Fifteen months ago she had been operated upon elsewhere. With partial relief but an open infected ulceration remained.

Fig. 10. Case No. 94350. Result after clearing up of infection and skin grafting.

What treatment should be used to minimize if not wholly prevent axillary webbing? The process which we have found produces webbing must be reversed. That is, the patient must be placed in a position that is compatible with comfort (Fig. 6) yet allows attention to be given his wounds and at the earliest possible moment the exposed surfaces must be covered over with skin grafts thereby permitting repair with a minimum of scar tissue (Figs. 7 and 8). Such treatment must be evaluated by the medical attendant, if in his judgment the patient's condition does not warrant it and if, in an effort to save life, axillary adhesions do result, the physician should not be condemned. On the other hand a long, drawn out convalescence with innumerable painful

drawings in an endeavor to allow nature to close in a large ulcer is most certainly open to criticism (Figs. 9 and 10).

When a case of axillary webbing in which the patient has recovered from the acute condition presents itself for treatment, how should it be handled. In choosing the proper treatment for each case many factors should be considered as for instance the age and general condition of the patient, the availability of material with which to work, and the severity and extent of the disability. John Stalge Davis has very concisely stated the problem. The object of the treatment is primarily the restoration of the function of the arm, with the relief of the deformity and the prevention of recurrence. The successful recoo-



Fig. 11

Fig. 12

Case No. 7148. Axillary adhesion of years' duration.

Case No. 7148. Result after Z-plasty operation as done.

Fig. 11
duration

Fig. 12
as done

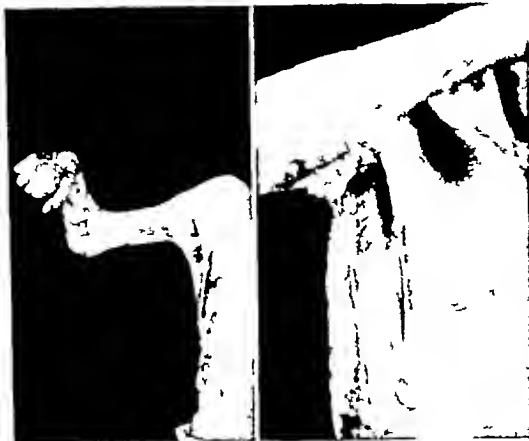


Fig 13



Fig 14

Fig 13 Case No 91533 Grade III contracture of axilla from old burn. This type of contracture is best treated by surgical attack at the point of maximum contracture as shown in Figure 14.

Fig 14 Case No 91533 Axilla and chest wall have been cleaned and prepared. The site of incision has been determined and is graphically shown.

struction or readjusting of the axillary space is the key to the relief of the condition."

I have found that the essential task to be effected, irrespective of the procedure, is either the complete removal of the cicatricial tissue or an interruption of its vicious line of pull. I have never had to resort to muscle sectioning or tendon lengthening, but I have relied upon secondary operations, carefully directed postoperative physical therapy, massage, and growth (Figs 11 and 12).

A recent review and study of 29 cases in which patients were treated during the past 7 years brought forth the following pertinent facts:

1 There were 5 patients, 21 years or older. In 1 the adhesions resulted from surgery, the 4 remaining followed burns, and of these, 3 patients were burned as a result of epileptic seizures.

2 Excluding the adults, who represented 18.2 per cent of the total, the average age was 8.7 years, a fact which shows that this is a condition most often found in children.



Fig 15, left The skin over the axillary folds has been under cut and pushed upward to normal position, thus leaving an epithelial defect low on lateral chest wall.

Fig 16 Case No 91533 Axilla restored to normal appearance and open area on chest wall covered with a split graft.



Fig. 7. Left Case N. 4238. Grade II contracture in 6 year old boy resulting after surgical correction. 1 age of 4 years.

Fig. 8. Correction by combination of Z plasty and low transverse skin graft.

3. There were 18 females and 12 males.

4. In 20 cases the adhesions followed burns from open fire.

5. The incidence of types showed grade II contractures, 14 grade III 9 grade I 4 and grade IV 3.

6. The type of operation used was (a) Z plasty, 15 cases (b) Z plasty and skin graft, 5 cases (c) tube graft, 1 case and (d) transverse incision and split graft, 8 cases.

7. Analysis of secondary operations showed (a) 11 patients who had had a Z plasty operation alone required secondary operations (b) patients returned for further work after a Z plasty with skin graft (c) of the transverse incision cases, only 2 patients required further work and this because the operation was done in stages.

8. Follow-up check-up gave the following results:



Fig. 9.

Fig. 30.

Fig. 9. Case N. 5795. Grade IV axillary web of 3 years' duration.

Fig. 30. Case N. 5795. Final result from four operations using Z plasty and transverse incision and skin grafts.

a. There were 8 patients operated upon 1 year ago, of these 2 had normal function and good anatomical reconstruction, 3 had good anatomical result with 25 per cent limitation of function, 1 had a small web postaxillary fold with 25 per cent limitation of function, 1 had a good anatomical result with 20 per cent limitation of function, 1 had a small web in the apex with 20 per cent limitation of function and 1 had webbing of the posterior fold and 20 per cent limitation of function. I feel that these will improve with time and use of the parts. At a later date they can be further surgically corrected.



Fig.

Fig.

Fig. 10. Case N. 55800. Grade IV axillary webbing of months' duration with deep sinuses and crypts.

Fig. 11. Tube graft in process of being made.

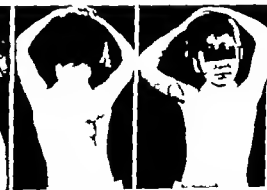


Fig. 11.

Fig. 11. Case N. 55800. The tube graft has been stepped into the defect and the axilla has been reconstructed. Note restoration of function.



Fig 24

Fig 24 Case No 72164 Grade III contracture of 10 months' duration

Fig 25

Fig 25 Case No 72164 Result 12 months after Z plasty operation and grafting ulcer on chest wall

b One patient operated upon 18 months previously has a good anatomical result with normal function

c There were 7 patients operated upon 2 years previously and of these 4 have good anatomical and functional results, 1 has a small web in the posterior fold that has excellent function, 1 has a good anatomical result with 10 to 20 per cent limitation of function, 1 patient with both axillæ involved shows limitation of function of 20 per cent in right and limitation of function of 40 per cent in left side

d There were 2 cases in the 3 year follow up and both showed good anatomical restoration and 100 per cent function

e In the 4 year follow up there were 2 cases Both had good anatomical and functional results

f In the 5 year follow up there were 3 cases One patient had a good anatomical and functional result, and 2 showed good functional results with small webs in the posterior axillary folds

g There was 1 patient in the 7 year follow up This patient has a good anatomical and perfect functional result

PLAN OF TREATMENT

As a result of the experience gained and the results obtained, the following plan of treatment has been evolved

Age I feel that unless there is marked deformity, that is a contracture of grade IV or more, no surgical treatment should be done until the child is 3 to 4 years of age

Preparation A thorough check up of the patient's general condition should always be made and any variations from normal corrected Should a patient show an anemia, his operation is postponed until the condition is relieved Any small ulcerations on the webs are healed Daily cleansing and preparing of the skin is carried out until the skin appears healthy Small sinuses, crypts,

and pockets are thoroughly cleaned out Ultra violet treatments or direct exposure to sunlight are quite often given

Operation The exact procedure will naturally depend upon the grade of contracture and the quality of the skin available

In grade I contractures, I have found the following to give the best results A transverse incision, usually 5 to 6 inches in length, is made completely through the cicatricial tissue down to muscle at a level of 4 to 6 inches above the crest of the ilium, thereby permitting the arm to be fully extended A diamond-shaped defect is thus created on the lateral side of the chest wall and lumbar region which can easily be covered with a split graft

This procedure not only corrects the contracture but does so with very little disturbance of the axilla (Figs 13 to 16)

In grade II contractures, if the webs are loose and of good blood supply, a Z plasty alone is done If deformity is not completely corrected after the Z plasty, a transverse incision is made and a skin graft is applied (Figs 17 and 18)

If the webs are dense, 2 or more operations of the transverse type, thus raising the arm in stages, are performed This technique tends to soften the webs by releasing the pull and allows them to assume the shape of the axillary folds as they are pushed upward (Figs 19 and 20)

In grade III and grade IV contractures the same technique as in grade II may be used but more stages are required If the contractures are too dense to be mobilized, two methods of procedure may be followed

A tube graft elsewhere on the body may be formed to furnish the tissues for the reconstruction of the axilla and "stepped" into position (Figs 21 to 23)

A plastic operation, which would free the contractures, permit the arm to be raised, and

cover the defect with a split graft is carried out and may be accomplished in 2 or more stages.

Splints, supports and dressings. The arm is elevated to the full amount of correction accomplished by the operation and compatible with good circulation of the forearm and the hand. This elevation must be maintained until the period of healing is ended usually 10 to 14 days.

When the patient is 3 to 6 years of age and difficult to keep quiet, we apply a sea sponge pressure dressing to the axilla and then put on a plaster shoulder spica. This is bivalved and the parts are dressed at the end of 7 to 9 days. The cast is then worn for another 7 to 10 days, as deemed necessary.

In older patients dressings are applied in the same manner but a cast is not worn. A thick pillow covered with rubber sheeting makes an excellent support, is more comfortable and lends itself to changes, and can as well be completely removed. It is not necessary for these patients to wear supports as long as it is for the younger patients.

Postoperative care. These patients are given ample sedatives for 24 hours then, depending upon the individual requirements of each patient, mild sedation to the point of definitely restricting activity for another 48 hours is carried out. Following this, patients are allowed bed movement but are not allowed up until fully 8 days after operation.

When they are allowed up, passive movements as well as gentle massage can be instituted. At the end of 10 days, active movements are started and from then on encouraged, but the individual is ever cautioned not to overstretch or injure the parts. We have found loom weaving, wheel exercises, and swimming to be excellent aids to restoring function.

CONCLUSIONS

1. The condition of brachiothoracic adhesions is a natural consequence of the physiological healing of two adjoining body surfaces in which there has been extensive epithelial loss.

2. Such lesions can be minimized, if not wholly prevented, by proper position well directed dressings, and early skin grafting. The use of painful splints or casts is of no real value and usually results in aggravation of the existing condition.

3. In the treatment of severe burns, when there is extreme shock, pain and loss of tissue it would seem that the decision to flow an arm to adhere to the chest wall to facilitate closing in of a large open area and at the same time to

afford protection to vital structures of the arm and forearm is surgically sound.

4. Axillary adhesions should not be treated by means of traction stretching or the wearing of appliances but by a definite surgical procedure. The problem of treatment is predicated upon the restoration of the arm, axilla and chest wall, to a condition as near to normal in appearance and function as is compatible with valuable tissues.

5. Extensive surgery of muscles, ligaments, and joint capsules is rarely indicated.

6. Patients must be permitted to grow and must be given time to readjust themselves before a final decision as to results is made (Figs. 24 and 25).

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THE SURGICAL TREATMENT OF RECURRENT DISLOCATION OF THE SHOULDER JOINT

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MANY methods have been worked out for the surgical treatment of habitual dislocation of the shoulder joint. In all of them attempt is made by the grafting of tissue to prevent luxation of the head of the humerus. The methods may be divided into three groups depending upon whether involvement includes (1) the joint capsule and joint ligaments, (2) the tendons and muscles, or (3) the bones of the joint. In addition, these methods have been combined in many ways.

Cases in the last group seem to offer the best possibilities of good results.

Eden, in Jena in 1917, was the first to use bone grafts for the treatment of habitual dislocation of the shoulder. His method consisted of transplanting a piece of the tibia to the anterior rim of the glenoid cavity so that the graft projected at least 10 millimeters from the rim, and then fastening it with periosteal sutures or with pegs under the raised periosteum of the neck of the scapula.

Only 10 days after Eden, Hybbinette performed a similar operation in Stockholm. He made a wide opening in the joint to secure good exposure and to permit observation of the articular changes in detail. At first he used a tibial graft. Later, however, due to observations made during operative procedures, he took a transplant from the iliac crest and inserted it into a periosteal pocket in the anterior lip of the glenoid cavity by means of a specially designed instrument. The transplant was provided with an edge to rest against the rim of the cavity, to prevent the graft from slipping too far into the periosteal pocket. The free edge of the transplant was made to project 3 to 4 millimeters in front of the rim of the socket. With this method Hybbinette obtained remarkably good results.

Subsequently, Oudard attached a free bone transplant obtained by chiselling obliquely through the coracoid process to the anterior glenoid margin. In 1924, Noesske modified Oudard's method. He chiselled obliquely into the coracoid process and bent down the flexible piece of bone so obtained toward the anterior rim of the cavity where he attached it. He thus used a sort of pedicled graft.

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In 1927, Speed described a method which consisted of boring a hole 1 inch deep extracapsularly into the inferior border of the scapular neck and inserting a tibial transplant into the canal so that it projected three-quarters of an inch in front of the articular border.

In 1937, Meyer-Burgdorff attempted to direct the plane of the glenoid cavity backward by removing a wedge of bone from the neck of the shoulder blade. His method seems to be rather radical.

According to Heep, 1937, the Hackenbroch clinic in Cologne uses the Eden method. They have modified the procedure, however, in that they make a split in the bone of the inferior border of the glenoid cavity and press the tibial graft into the bony bed thus obtained, in order to prevent displacement between the transplant and the rim of the glenoid. They are careful to attach the tibial graft in exactly the right place, to prevent a recurrence. After the operation the shoulder joint is put in a plaster-of-Paris cast, in abduction, and the cast is worn for 3 or 4 weeks.

Since it is so important that the implanted bone be well attached to the scapula, I shall now describe a method of operation which resembles that of Speed and which I used in a case of habitual dislocation of the shoulder. This technique provides remarkably good immediate fixation of the bone implant. The procedure is simple and time-saving.

CASE REPORT

A married woman of 34 years had suffered from recurrent dislocation of the right shoulder since 1932. One day she fell down and knocked her shoulder out of joint, but she had no difficulty in putting it back into place herself. After that, certain movements were painful, especially when she extended her arm, which caused a "twinge" in her shoulder. The dislocation recurred and gradually increased in frequency from once every few months to several times a week. She was always able to replace the head in the joint herself until November 28, 1938, when she found it necessary to consult a physician. From then on it was difficult to reduce the dislocation. She was admitted to Värnamo Hospital on January 13, 1938. Her shoulder had then been out of joint 3 hours and could not be replaced. After immediate reduction under anesthetic and fixation of the shoulder in a bandage, the patient insisted upon an operation.

Operation, consisting of bone implantation in the anterior rim of the scapula, was performed under evapal

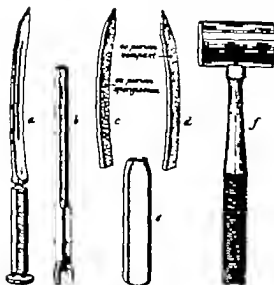


Fig. 2. a, Osteoperforator; b, instrument to assist the extraction of osteoperforator; c, pointed, arched os porum transplant, the convex wall of which consists of compact bone and the concave wall of spongy bone; d, ballista handle, which may be used to help drive in the os porum graft; e, operative mallet.

anesthesia on January 5, 1930 (Orell). An incision was made from the coracoid process down along the arm between the pectoralis major and deltoid muscles. The joint capsule was divided in the anterior part of the joint, and finger was inserted for palpation of the rim of the glenoid cavity. The extracapsular soft parts, including the subscapularis muscle, were bluntly divided all the way to the anterior edge of the glenoid cavity. Then the periosteum was loosened from the scapula and a specially designed osteoperforator (Fig. 2a) of the same shape as pointed lamella of os porum (Fig. 2c) was driven into the scapular bone immediately medial to the anterior edge of the glenoid cavity. After the osteoperforator was removed with the help of special instrument (Fig. 2b), an os porum lamella was driven extracapsularly into the cleft until it was securely in place. Most of the os porum graft was slipped off to leave only the amount required to prevent the head from slipping past the glenoid cavity's anterior edge. The os was sutured in layers and the arm was fixed in an ordinary bandage.

Healing was primary. During the first weeks after operation the arm was kept in adduction. For the next weeks the patient performed exercises under the direction of gymnast, after which she returned home and did the exercises by herself.

When the patient came back for re-examination on July 30, 1930, she stated that since the operation in January 1930, she had never experienced any of the old pain or trouble. The joint felt stable and in spite of the fact that since her discharge in February she had gone back to doing all her own housework, she has had no dislocation. The muscles in the right shoulder are just as strong as those in the left. There is no atrophy. The strength of both arms appeared to be equal. She could not lift the right arm quite as high as the left, but the difference was not great (Fig. 3). She was able to throw baseball.



Fig. 3. The patient 6 1/2 months after operation, standing with her arms lifted high (sketch taken from 6 millimeter film).

This operation is very simple and requires but short time. Naturally the osteoperforator must be manipulated so that its sharp point, which is controlled by the finger inserted through the hole made in the anterior wall of the joint capsule, does not slip but becomes fixed immediately in the bone. Nor should the scapular bone be cracked. Its tissue seems to be very homogeneous and finely meshed so that there is no risk of cracking if the operative mallet is handled carefully and sensitively. When the osteoperforator has been removed there seems to be no difficulty in driving in the similarly shaped os porum graft. Moreover with the use of os porum one avoids the loss of time incurred in taking a bone transplant from another part of the body.

Insertion of a thin strip of bone extracapsularly in the anterior edge of the scapula appears to be sufficient to prevent recurrent dislocation. It has been said that the atrophy of the capsule after an operation following the method of Eden or Hyblinette is essential for a successful result, and that it is therefore very important that the arm be maintained in adduction for a long time after the operation. Such a step however involves a risk of considerable limitation of movement, which may later be difficult or impossible to eliminate. For this reason it seems to me that, if possible, the arm should not be fixed for more than 10 to 14 days after operation. With the aforementioned procedure in which the atrophy of the capsule is clearly of minor importance it should be possible



Fig 3 Roentgenograms of the right shoulder joint a, Left, 6 days after operation—the os purum transplant is seen in the anterior edge of the joint cavity b, 222 days after operation—the os purum graft is largely resorbed The joint cavity has a normal appearance

to cut down the period of fixation of the arm to a still shorter time, since the inserted os purum graft fits tightly into the scapula, and as a result of the compression of the bony parts, the connective tissue in the spongiosa of the scapula has every chance of quickly growing into the canal system of the graft and "soldering" it by means of living tissue. Probably most of the os purum lamella will be resorbed, but enough should be reconstructed in new bone, due to the mechanical stress between the head of the humerus and the rim of the glenoid cavity, to prevent luxation (Fig 3)

SUMMARY

A method of operation for habitual dislocation of the shoulder joint is described. It consists in making a cleft or fissure extracapsularly in the desired place in the rim of the glenoid cavity by means of a specially designed osteoperforator and inserting into it a pointed os purum transplant. The graft is nipped off so that it projects only slightly beyond the rim of the glenoid. Due to the fact that the cleft in the scapula and one side of the os purum lamella consist of spongy bone, a remarkably good immediate fixation between them is obtained. This is later completed by the bone-forming connective tissue from the scapula, gradually growing into the graft. This bone formation seems to be sufficient to prevent luxation, even after most of the os purum transplant has been resorbed. The postoperative fixation of the shoulder and the resulting stiffness of the joint can in

this way be reduced to a minimum. The operative method is technically simple and time-saving, since the transplant is not taken from another part of the body.

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SPECIAL FEATURES IN THE MANAGEMENT OF SURGICAL DIFFICULT MALIGNANT GROWTHS AND KINDRED LESIONS OF THE PELVIC VISCERA

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AN intensive study of pelvic anatomy both in the operating room and in anatomical dissections has been carried on with Dr. Barry J. Anson. Not only because of his originality in the pursuit of gross anatomy but also because of his keen interest in the adaptation of what we have learned to the solution of clinical problems, I am particularly grateful to my co-worker.

PELVIC ANATOMY IN RELATION TO SOME DETAILS OF GYNECOLOGICAL DIAGNOSIS AND SURGICAL TECHNIQUE

Attention is directed to the cellular tissues of the pelvis, for the pathway of the lymphatics and blood vessels is entirely by way of these cellular tissues; therefore an exact knowledge of the latter will portray in detail the route by which infections spread and cancer invades. Cellular tissue is comprised of connective tissue cells and may serve as loose packing as in the areolar tissue within the broad ligament or it may be more dense, tense and firm, thus constituting ligamentous tissue. Furthermore the connective tissue fibrils may serve as a filler or they may form a firm fascial covering or a thin, more or less incomplete sheet, which gradually fades away like the thin bark on a white birch tree.

In a recent publication concerned with cystocele it was demonstrated that after removal of the intestines, peritoneum, and subserous tissue the firm fascia which lines the muscles of the pelvic floor is reflected upward as a collar over each of the three hollow viscera, namely the bladder, the vagina and uterus, and the rectum. The relatively thin collar around the bladder is in apposition with the heavier vaginal uterine collar, the bladder pillars constituting a connecting bridge.

More recent observation in the operating room correlated with anatomical dissections have demonstrated the continuity of the investing fascial collars with the supporting structures at a higher level. Proceeding from above downward, the fascial investment over the uterus first becomes distinct posteriorly slightly above the level of the uterine attachment of the uteroantral ligaments. Anteriorly is noted a remarkably broad attachment of the round ligaments down to the level of the broad ligament branch of the uterine vein. Immediately below this point the fascial collar becomes dissectable.

Lateralward, the uterovaginal and vesical fascial coverings become continuous with the Mackenrodt ligament which spreads out tent-like, to become inserted, fan-shaped, into the fascia overlying the obturator muscle and the muscles of the pelvic diaphragm. With the peritoneum removed one sees that Mackenrodt's ligament really begins above at the level of the obliquely crossing broad ligament branch of the uterine vein and that there is a core consisting of this vein and the slightly more inferiorly placed uterine artery and accompanying vein all enclosed in a vascular compartment, one notes also posteriorly that the uteroantral ligament is continuous laterally with and really is an integral part of Mackenrodt's ligament, as well as continuous with the uterovaginal fascial collar upward and downward extensions of the fascial sheath surrounding the vessels constitute firm investments accompanying the ascending and vaginal branches of the uterine artery and vein.

The course of the ureters is a topic of never ending interest and concern even to those most experienced. Noteworthy surgical landmarks therefore merit a few words. When the pelvis is entered the ureter is found to lie immediately medial to the attachment of the infundibulopelvic ligament at the pelvic brim. Therefore in peritonization, after removal of the uterus together with the ovaries, the ureter is hazardously near just beneath the peritoneum and the peritonizing suture should never be placed deeply on the medial side without preliminary palpation of

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The anatomy of the subperitoneal tissues and ligamentous structures in relation to surgery of the female pelvic viscera.
Surg. Gynec. & Obst. 50: 70-83, 1930.

the ureter Located 4 centimeters from the uterus at the level of the internal os, the ureters are 1.5 centimeters lateral to the lowermost cervix at the point of their greatest proximity to the uterus, in their downward course they lie beneath the tent-like, fan-shaped, lateral extensions of Mackenrodt's ligaments, crossing under the uterine vessels, and are situated approximately 8 centimeters apart at the level where the pelvic surgeon usually places clamps on the vagina in performing a simple, complete hysterectomy Another landmark is afforded by the bladder pillars, the ureters are located just anterior to and 1 centimeter lateral to the pillars In the detail of radical hysterectomy for cancer it is helpful to know that the ureters enter the bladder obliquely convergent and are ensheathed in extensions of the musculo-fascial covering of the bladder Also worthy of emphasis is the fact that a considerable fascial investment extends along the ureter, thus creating a pathway for lymphatic drainage from the cellular tissues contained within Mackenrodt's ligament

All of this means that a new concept is available in appraisal of local extension of cancer beyond the confines of the uterus The spread of cancer is inevitably through the cellular tissues along the fascial planes which have been depicted With detailed knowledge¹ of the cellular anatomy of the female pelvis now available, local metastases may be expressed in terms of interstitial involvement, superseding our heretofore hazy understanding of lymphatic anatomy and lymphatic drainage Palpation of the tissues in an attempt to evaluate the invasion of these anatomically definite routes of extension promises to yield more trustworthy deductions relative to the extent of the malignant process, likewise, evaluation of the condition of the cellular tissues as well as the glands encountered at operation should be preferable to attention concentrated on palpation of the lymph nodes

The anatomy of the bladder in relation to pelvic surgery is intriguing The musculo-fascial investment is fortunately somewhat thicker on the inferior surface and is greatly strengthened by the contiguous, very much thicker musculo-fascial collar of the vagina and cervix At complete hysterectomy, however, we separate in the plane between the vesical and the cervicovaginal collars, where the vesical fascia is much attenuated, with the result that the integrity of the bladder wall is often endangered This I have demonstrated repeatedly through the simple expedient of pre-operative instillation of 20 cubic centimeters of 1:1,000 methylene blue solution into the

empty bladder as a safeguard the blue solution shines through unduly denuded areas, warning of danger, and it spills in case of injury In this connection, I am impelled to emphasize the frequency with which one invades the musculo-fascial envelope of the bladder in the routine of complete hysterectomy, and also the hazard of tissue forceps' injury and leakage from the bladder which doubtless is accountable for some of the cases of fistula heretofore ascribed to the too deep placement of sutures The fascial wings over the bladder spread far laterally, and the bladder and ureter tend to fall farther laterally upon surgical dissection than one might surmise Therefore, in the performance of a magnified Wertheim operation, zealous removal of all available cellular tissue in the deep pelvis lateral to the ureter is somewhat hazardous

MANAGEMENT OF CASES WITH (1) GROWTHS EN-CROACHING UPON OR INVADING THE BLADDER, (2) INSEPARABLE WELDING OF THE BLADDER TO THE UTERUS, (3) INSEPARABLE OBLITERATING CUL-DE-SAC ADHESIONS OR TUMOROUS INVASION OF THE CUL-DE-SAC, (4) UNILATERAL EXTENSION OF MALIGNANT OR OTHER INVASIVE GROWTHS

With added experience the impression has been gained that with dissection along fascial planes in the removal of most genital pathological lesions, the tissues operated upon may be made to fall apart, and that thereafter they fall together readily in completing the operation Such blunt dissection is inevitably more gentle, and tissues united without tension heal kindly with lessened distress during convalescence This does not imply that work may be done without awareness of the fact that waste of time increases morbidity and mortality

Cases of carcinoma of the body of the uterus, of the lower corpus or endocervix, and cases of pelvic endometriosis may involve the bladder sufficiently to make hysterectomy hazardous (Fig 1) Those cases in which resection of the bladder is indicated will not be dwelt upon In all other such instances the technique is essentially as simple as in the performance of an ordinary hysterectomy if one leaves the bladder undisturbed until the uterus is otherwise freed, then, with excellent visibility and perfect control, the uterus separates from the bladder without effort along natural lines of cleavage With this procedure, as well as in those difficult adherent cases in which it appears expedient to separate the bladder according to the more usual technique, or perhaps with approach from the lateral aspect, methylene blue solution in the bladder is a safeguard

¹Loc. cit.



Fig. 1. Adenocarcinoma of lower uterine corpus and endocervix with invasion of wall of bladder.

Another group of cases to be considered are those with obliterating lesions of the cul-de-sac with welding of the rectum to the vagina and cervix. It is self-evident that cases of endometriosis in which both ovaries are to be removed require no cul-de-sac surgery. But if one ovary is to be spared, also in cases with other tumorous lesions or cellulitis of the cul-de-sac, dissection of this region may be indicated. Here, analogous to the procedure in cases with a firmly welded bladder the cul-de-sac dissection may be reserved advantageously for the final step which makes the technique less formidable and the hazard of rectal injury minimal.

Present day emphasis on simplification of the technique of complete hysterectomy by generous mobilization of the bladder and particularly by freeing the uterus posteriorly and posterolaterally has militated against our appreciation of other procedures. In cases with firm fixation of the bladder and an immobile rectum a complete hysterectomy can be accomplished from side to side with facility and with greater ease and less hazard dissection of these viscera can be reserved for the final steps of the procedure with separation of the more inaccessible viscera last.

Among the reasons for the 50 per cent death rate from corpus cancer are (1) the tendency to tubal spill with extension to the ovary and peritoneum and invasion of the contiguous cellular tissues and (2) extension of lower corpus growths either directly or via the endocervix to the lymphatics of the vascular compartment and cellular tissues of the Mackenrodt ligament. Such extensions are often patently unilateral those

from ovarian growths, tubal carcinoma and endometriosis may also be unilateral. In many such cases the customary simple removal of the uterus and adnexa may be supplanted advantageously by unilateral simple division of the tissues on the uninvaded side of the uterus, with exposure of the ureter and a Wertheim procedure on the side of greater invasion a magnified Wertheim complete eradication of all removable structures may be resorted to in extreme cases.

A great many years ago there was strong complacency relative to the idea that removal of a major pelvic tumor mass often spares life for many years, despite failure to eradicate the growth in its entirety. Now it is known that extensive surgery with exposure of the ureter and removal of all available cellular structures, usually unilateral sometimes bilateral, greatly increases the expectancy of selected patients of this group even those with an extensive omental cake and implants which are not removed can be controlled by roentgen therapy.

CARCINOMA OF THE CERVIX

The operative treatment of carcinoma of the cervix will be omitted and only a summarized listing will be given of essential details in the non-operative management of this last and most important item among the subjects selected for discussion.

1. A well trained gynecologist should be able to diagnose carcinoma of the cervix from its gross appearance alone in nearly all instances. I have no brief against routine preliminary removal of fragments of tissue for biopsy study before venturing a diagnosis, but I do not often resort to this procedure. On the other hand I frequently find that establishment of a certain diagnosis necessitates examination under anesthesia, often with instrumentation to provide adequate exposure and to determine the exact nature of atypical or hidden areas. I not only condone such examinations, but would emphasize the value of the study of cervical cancer patients when thus asleep in order to evaluate the intricacies of the therapeutic problem which confront us.

At the time of the examination in the operating room it is my custom to state definitely "It is,

It is not, or I do not know whether it is cancer. Treatment is instituted immediately in nearly all instances and is delayed only in that small percentage of cases in which the diagnosis is in doubt and must wait microscopic examination. Tissue is invariably taken for biopsy to make final confirmation of the diagnosis and to determine the type of growth.

2 In the event that no malignancy is grossly recognizable, which usually means that malignancy is unlikely, the diseased area should be removed *in toto* as a prophylactic and diagnostic measure, the entire excised tissue immediately sliced for gross inspection, and all of the several pieces so obtained imbedded for microscopical study of one or more sections from each. We rarely find it helpful to resort to the Schiller test or colposcopic examination, but believe we should remain somewhat open-minded about the latter.

3 Non-ulcerated, non-infected cases of cancer with a favorable prognosis (Fig 2), i.e., stage I and stage II clean cases, are treated with a tandem of radium capsules within the canal together with radium needles imbedded in a palisade encircling the cervix. Some maintain, and probably with reason, that radium within the canal together with radium placed against the cervix is equally efficacious. Our usual dosage varies from 3,500 to 4,500 milligram hours. No further radium treatment is required for many months, at least, in these clean cases, but these patients should be seen frequently and the cervical canal kept well dilated.

4 In all cases of cervical cancer with a serious prognosis an intravenous pyelo-ureterogram is indicated, in order to determine whether there is involvement of the urinary tract.

5 Ulcerated or craterous, necrotic cancer must be healed on the surface before intensive radiation is used to avoid the danger of pelvic cellulitis. Surface healing may be accomplished with surgical diathermy or with a palliative radium application of 1,000 to 1,500 milligram hours, preferably in a bomb. Many weeks later, after healing of the necrotic surface, radium treatment may be given as described for non-infected, favorable cases.

Some of this group cannot be radiated adequately without endangering the bladder or ureters, in such instances, simple vaginal dissection readily places them out of harm's way. With the bladder safely anchored in an elevated position we may give intensive radium treatment with selective implantation of needles in the musculofascial parametrial tissues aided by radium capsules within the uterine canal.

After preliminary radium treatment has healed the surface, patients with deeply craterous cancer and others with relatively advanced lesions are treated conservatively with a radium bomb against the cervix. Painsstaking care is essential in order to avoid destructive overtreatment. Patients with hopelessly extensive and deeply ulcerated cancer may receive no treatment



Fig 2 Typical squamous cell carcinoma of cervix

other than roentgen therapy, but even this must be administered with caution, for the possibility of cure is slight and of doing harm is great.

6 Intensive high voltage roentgen therapy is instituted immediately in all cervical cancer cases as soon as a diagnosis is established, and the patient is carefully watched and guarded against the hazard of overtreatment which is considerable. Roentgen therapy is a great boon. But, as we learned some years ago, it is not innocuous, thus, in one bad case in which the patient was treated intensively, there was leucopenia, a clinical picture of agranulocytosis. This patient died with myriads of small ulcerations of the colon but not a vestige of cancer was discovered at autopsy.

7 And now for a suggestion to which many may not be receptive. Howard Kelly was right when he stated that 85 per cent of the value of radium therapy lies in the first treatment and 85 per cent of the harm which we do is ascribable to subsequent radiation. But that dictum, admirable with the knowledge and methods of early days of radiation therapy, is no longer applicable with our somewhat widened vision. The extent of the cancerous lesion cannot be appraised accurately in the majority of serious cases at the time of the first treatment. Therefore, I have found it immeasurably helpful to make another painstaking study almost routinely under anesthesia, several months or a year or more subsequent to the first intensive treatment with radium. One can then determine with considerable precision and in detail what has been accomplished. Such an examination should, of course, be made with radium on hand and with instruments prepared for simple surgical intervention.

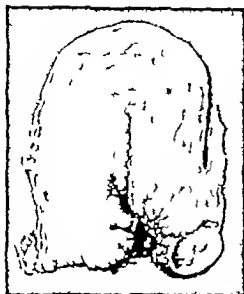


Fig. 3. Carcinoma developed in cervical stump.

to insure satisfactory placement of the radium. The following is only one of many cases in point:

A patient was brought on the history of prolonged, supposedly functional bleeding. Palpation was negative, but hidden cancer was suspected. Under anesthesia found an endocervical malignancy, the cervix craterous shell, the bladder resting on a thin film of cervix anteriorly and the cervico-ecial all so thin that it felt like a floating fetal sac. Tissue was obtained for histological study: fibrous fear and trembling gave 800 milligram hours of radium within the canal, then instituted roentgen therapy and 3 weeks later applied radium bomb to the cervix. After 4 months, examination under anesthesia revealed smoothly beveled surfaces, the cervix firm thin shell, anteriorly of tissue paper thickness. The bladder was mobilized by blunt dissection and shoved upward; the uterus was pulled downward so that the internal os became the external os, and then it was possible to treat with external radiation. The patient has remained free from evidence of cancer on repeated examinations under anesthesia.

8. Cancer of the cervical stump (Fig. 3) may be treated by radiation alone but we prefer removal and radiation in those patients in whom the growth is limited apparently to the cervix and we employ radiation followed by subsequent removal in all other cases except those which are hopelessly extensive. My advocacy of surgical removal, in preference to roentgen radium radiation alone is prompted by bad results from treatment solely with radiation therapy also by the simplicity of vaginal removal of the cancerous

stump, and by the fact that it is usually impossible to estimate the extent of the cancerous process in these cervical stump cases and therefore difficult to determine the amount of radiation required without exploration to reveal the stage of the disease. These views relative to the management of cancer of the cervical stump are still in a state of flux, subject to revision.

CONCLUSIONS

With detailed knowledge of the gross cellular anatomy of the female pelvis now available in appraisal of extension of cancer beyond the confines of the uterus, local metastases may be expressed in terms of terminal involvement superseding our heretofore hazy understanding of lymphatic drainage.

2. Experience in dissection of the pelvic cellular tissues makes it conclusively evident that radical vaginal hysterectomy irrespective of the talent of the surgeon cannot rival the thoroughness of procedure which is possible in extirpation of the cancer vulnerable tissues from the abdominal approach.

3. Instillation of 20 cubic centimeters of 1:1,000 methylene blue solution into the empty bladder is adequate protection against vesical injury during difficult pelvic operations.

4. In cases with firm welding of the bladder to the uterus, thus making hysterectomy hazardous the operative technique is simplified by leaving the bladder undisturbed until the uterus is otherwise completely freed, when separation may be effected without effort, along natural lines of cleavage.

5. In many cases with formidable pelvic pathological lesions the operative hazard may be lessened and the thoroughness of the procedure increased by simple freeing of the uterus on one side, integrated with exposure of the ureter and radical removal on the more involved side and the procedure perhaps further modified to advantage by removal from side to side rather than by the more usual, established technique.

6. It is helpful to examine patients with cervical cancer under anesthesia—particularly those with a hidden or extensive lesion—in order to determine the extent of the process, to evaluate the intricacies of the therapeutic problem which confront us, and to administer treatment to greatest advantage. Subsequent re-examinations under anesthesia are of invaluable aid in considerable percentage of cases.

THE RESULTS OF THE TREATMENT OF BILOCULAR AND DIRECT INGUINAL HERNIAS

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THE recent reports of the results obtained in the treatment of primary bilocular or mixed hernias and direct inguinal hernias are quite discouraging. It has been stated that the incidence of recurrence in these types of hernias alone varies between 18 and 32 per cent (1, 3, 7, 13). In this article we are presenting a comparative study made in a majority of primary inguinal herniorrhaphies of the bilocular and direct types performed in our Surgical Service between December, 1934, and April, 1938. During this period primary inguinal hernias totaling 1,161 were corrected. However, in this report we are including only the studies made in 711 of these herniorrhaphies which have been properly followed up. The types of hernias encountered in this follow-up group with very few exceptions were either of the bilocular type or of the direct type. This series in itself is considered unique inasmuch as the group of patients operated upon were men between the fourth and fifth decades of life. So far as we have been able to ascertain, an exclusive report in the surgical literature dealing with the results obtained following hernioplastic procedures in individuals of this age group has not been made. It is a well known fact that between the ages of 40 and 50 years, the tendency for recurrence of hernias is at its highest (1, 7), and in this series 99 per cent of the cases reported are in this age group.

The group of patients operated upon were all ex-service men. The average age was a little above 43 years at the time of operation. As would be expected, a large number of these patients showed early manifestations of degenerative disorders characteristic of this age group such as chronic cough or bronchitis, arteriosclerosis, hypertensive and articular disorders, etc. In general the surgical risk was considered fair in most instances. In the follow-up studies it was possible to contact adequately a total of 537 individuals or patients on whom a total of 711 herniorrhaphies have been performed. Of this total, 322 individuals (426 herniorrhaphies) have been examined by the patients' private physicians, by industrial surgeons at the place of their employment, by us personally, or by other Government physicians. In 215 instances (285 herniorrhaphies) the statements

made by the patients have been taken as *prima facie* evidence of the results obtained following the operations and the reported percentage of recurrences in this group is higher than in the first group (Tables II, III, IV). These statements are considered by us fairly reliable for all purposes as it has been our experience to find that in most instances the patient's complaints and history in regard to hernias of any kind tally with the regional findings on examination. To be consistent in our statistical analysis, we have taken into consideration that "local bulging" in any degree whether reported by examinations of other physicians or by simple correspondence with the patients is evidence of recurrence of the hernioplasty. We all are aware that local bulging *per se* following hernioplastic procedures is not always a manifestation of a recurrence, and that the absence of bulging and local symptoms is not always a sign of satisfactory results following the operation. Nevertheless, we feel that the statistical error if any in our computations as done would be evenly balanced. In the comparative studies of the cases followed up we have concentrated our attention on the following points of importance: (1) types of hernias found as to side and sac formations, (2) comparative values of the technique used, (3) relative value of the different suture materials used, (4) incidence of recurrences, (5) miscellaneous data, infection, mortality, complications, etc.

TABLE I—TYPES OF HERNIA

	Cases	Cases
Right sided		333
a Femoral	5	
Left sided		242
a Femoral	4	
b Sliding	3	
Bilateral		293
a Femoral	4	
b Sliding	1	
Total cases		868
Total hernias		1,161

1 Types of hernias found From the data in Table I we have found that the right inguinal hernias are about 35 per cent more frequent than the left inguinal hernias and only slightly more common than the bilateral inguinal hernias. The percentage of femoral as well as of sliding hernias

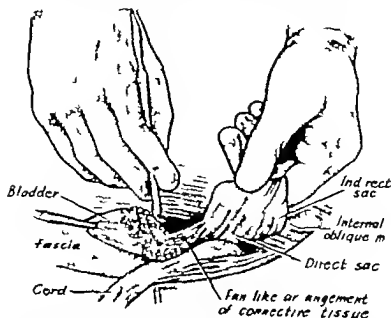


Fig. Illustration demonstrating the final stage in the dissection of the direct locules from the bladder wall. The fan-like arrangement of the lateral crural fascia serves as excellent line of cleavage. The deep epigastric vessels have been displaced medially and forward. The direct locules have been reduced with the formation of one large locule just lateral to the vessels mentioned.

found is considered within the accepted statistical limits (9).

In this series of cases the majority approximately 66 per cent, of the hernia defects encountered at the time of the operations were of the bilocular type (mixed type indirect-direct type) with the direct out-pouching of the bilocular sacs predominating. The pure monolocular direct defects were found in approximately 30 per cent of the cases. The pure indirect defects, femoral hernias, and sliding hernias, were found in approximately 4 per cent of the total patients operated upon. This finding does not conform with the usual conception that the direct monolocular hernias have a much greater incidence after the fourth decade of life than any other types of hernial defects (3). It has been our routine to approach all hernial sacs at the level of the internal rings and invariably we have been able to demonstrate indirect locules or sacs arising in size from a few centimeters in dimension to large hernial sacs. By approaching the hernial sac at the level of the internal ring it is possible to dissect all the direct locules and at the same time to carry on a digital exploration of the under surface

of the inguinal floor. In this exploration the surgeon gains important information such as the strength of the fascia transversalis, the presence or absence of diverticular defects, and the patency of the femoral ring. By this method of approach there is less likelihood of overlooking unusual defects. Many surgeons prefer to invert the direct protrusions without excising the peritoneal locules, whereas they invariably dissect and excise the oblique peritoneal sacs. This is obviously inconsistent and paradoxical (the non-removal of the direct peritoneal locules) and it is our opinion that this is one of the reasons for the high incidence of recurrence following the repair of direct and bilocular inguinal hernial defects. Czerny quoting Coley attempted in the later part of last century to correct oblique hernias without excising the indirect sacs and his results were disastrous. On the other hand Bassini's results were relatively brilliant as he stressed and practiced the high ligation and excision of the indirect sacs.

Comparative value of the techniques used. It is hard to evaluate the merits of given surgical procedure when this is done by different surgeons. However we are in a position to do this with the

least possible error as our surgical staff is compact and closely supervised. All the surgeons who performed the herniorrhaphies reported in this series were very meticulous in the excision of all locules of the hernial sacs (Fig. 1) and similarly all carried out the digital exploration of the under surface of the inguinal canals. In the reconstructive procedures some variations were followed and we have been able to classify them accordingly.

a In 240 herniorrhaphies the reconstruction of the posterior walls was performed according to the method of Bassini with slight variations and the use chiefly of 20 day chromic catgut sutures. In this group there have been reported 31 recurrences, or 12.8 per cent of the total repairs done according to this method.

b In 457 herniorrhaphies the reconstruction of the walls was carried out according to a method recently described by us (12), in which we used strictly a fascial closure and fine black silk sutures. In this group there has been found 34 recurrences, or 7.5 per cent of the total repairs done according to this method.

c In 14 herniorrhaphies the reconstruction of the posterior walls was carried out according to the method of Gallie or its modifications and sutures were of fascial strips either from the aponeurosis of the external oblique or from the fascia lata. In this group we have 2 recurrences, or 14.2 per cent of the total repairs done.

As will be noticed, the percentage recurrence regardless of the technique followed is far below the 18 to 32 per cent reported by many authors in their series of bilocular and direct hernias (1, 3, 7, 13). Dr. Gallie, as quoted by Nilsson in the Hunterian Lecture delivered by him at the Royal College of Surgeons in England in 1924, stated that the examinations of hospital records showed a recurrence rate of 40 to 50 per cent of all direct hernias operated upon. Technically our series of cases for comparative purposes falls in the group of direct hernias. We attribute the low percentage recurrence in this series presented as compared with other reported series (1, 3, 7, 13) to two main factors, (1) the thorough excision of all peritoneal locules in the hernial defects, (2) we rarely overlook minor concomitant defects responsible to some extent for recurrences, such as diverticula, large femoral rings, attenuated fascia transversalis or Poupert's ligament, etc. This low recurrence factor is achieved only by the help afforded by the routine digital exploration of the under surface of the inguinal floor which permits the surgeon in the reconstruction to introduce the minor variations needed to correct defects which might be primary factors in causing recurrence.

3 *Relative values of different sutures used* (a) Silk suture was used exclusively in 457 herniorrhaphies with a percentage recurrence of 7.5 per cent. It was also used as supplementary suture in 14 other cases. In our experience the rate of recurrence when silk is used is much lower than when chromic catgut or fascial strips are used. It has been reported (8) that when silk is used the postoperative exudative phase of the healing process is much shorter than with chromic catgut and also that the fibroblastic processes are of greater magnitude or extent. It is obvious that with silk sutures the final strength of the wound is greater than with catgut. These two virtues in silk make this suture the ideal one for the correction of hernial defects when fibroplasia is of utmost importance (11). Moreover silk is a well standardized suture. One disadvantage of silk is that it is a harder suture to handle and another disadvantage is that the technique has to be observed more closely as any infection means prolonged postoperative drainage from the wound which persists until the infected silk sutures are extruded. Occasionally a second minor operation is required to fetch the infected sutures in order to expedite the healing of the wound.

b Chromic catgut suture was used exclusively in 240 herniorrhaphies with a percentage recurrence of 12.8 per cent. This suture has its advantages over silk but these are chiefly technical ones. It is an easier suture to work with and as a rule is a well standardized suture. Similarly in unexpected wound infections the drainage is of shorter duration and a second minor operation is rarely indicated. However, its power to stimulate fibroplasia is much lower than that of silk, and therefore it is a less advantageous suture in the repair of hernial defects.

c Autogenous fascial strips as suture material was used in 14 cases with a percentage recurrence of 14.2 per cent. In our opinion this suture has no special advantages over silk or chromic catgut sutures except in those instances in which there is not only relaxation but also structural weakness of the fascia transversalis. Similarly this suture is of value in all instances in which the fascia transversalis is rather short and its approximation to the under shelf and shelf of Poupert's ligament has to be made under some tension. There have been discouraging reports (1, 3) about the value of fascial strips in the repair of hernias but there is no doubt in our minds that this suture is extremely valuable in the cases indicated.

4 *Incidence of recurrences* The incidence of recurrences as shown in Tables II, III, and IV seems to be higher in the first 3 years after the

TABLE II.—RIGHT INGUINAL HERNIORRHAPHIES

Follow-up in months	Number of cases	Recurrences
6 to	7	3
3 to 24	59	7
31 to 36	14	7
37 to 48	6	6
49 to 54	26	—
Total cases	7	7
Examined by physicians		
Direct correspondence.	96	5

TABLE IV.—BILATERAL INGUINAL HERNIORRHAPHIES

Follow-up in months	Number of cases	Recurrences right	Recurrences left	Total
6 to	3	—	—	—
3 to 24	49	—	—	—
31 to 36	4	—	—	—
37 to 48	44	—	—	—
49 to 54	—	—	—	—
Total hernias	148	3	26	29
Examined by physicians, 94 cases, 208 hernias, 20 hernias				
Direct correspondence 70 cases, 140 hernias 6 cases, 6 hernias				

TABLE III.—LEFT INGUINAL HERNIORRHAPHIES

Follow-up in months	Number of cases	Recurrences
6 to	5	5
3 to 24	37	—
31 to 36	30	—
37 to 48	42	—
49 to 54	—	—
Total cases	145	9
Examined by physicians		
Direct correspondence.	97	4
	49	5

TABLE V.—COMPLICATIONS

Pneumonia, all types	3
Accidental opening of bladder	—
Abnormal space of Retzius	—
Severe paralytic ileus	—
Volvulus with obstruction	—
Acute hemorrhagic nephritis	—
Infection of wound	—
Ochthia	3
Transitory cystitis	7

of 54 months. However we feel that still the number of recurrences would be comparatively a low one.

5. *Anesthetic data.* a. *Anesthesia.* In 770 cases out of a total of 868 cases spinal anesthesia was used. Local anesthesia and other anesthetics were used only when there was a definite contra-indication for the use of the spinal anesthesia and also in those few cases in which the spinal anesthetic failed to be fixed partially or entirely. In this series spinal anesthesia in the type of cases in which operation was done was found to be invaluable.

b. *Complications.* In addition to these major complications there were the minor ones such as postoperative acute urinary retention, mild nausea, mild vomiting, headaches, gas pains, etc.

c. *Mortality.* Four deaths occurred in the total of 868 patients operated upon. These deaths were attributed to the following complications: volvulus with obstruction, autopsy severe paralytic ileus autopsy acute hemorrhagic nephritis, no autopsy and postoperative pneumonia, no autopsy. The mortality rate was 0.46 per cent.

d. *Postoperative care.* In unilateral uncomplicated hernia the patients stayed in bed an average of 8 days. In bilateral uncomplicated hernias the patients were kept in bed on an average of 11 days. Patients were instructed to move from side to side to avoid congestive pulmonary changes. Sedatives and laxatives were given as indicated. At time of discharge all patients were instructed not to do any lifting in excess of 20 pounds for a 6 months period.

operations. Of a total of 67 recurrences, 40 of them, or 71.2 per cent, appeared during the first 3 years. Thereafter the incidence of recurrences seems to taper down. In a recent analysis done by us in recurrent hernias operated upon we found that the recurrences similarly were higher in the first 3 years. It might be interesting to call attention to the fact that right inguinal herniorrhaphies have a much higher tendency to recur than the left inguinal herniorrhaphies. The probable explanation of this phenomenon is a simple one. The stresses to which the right inguinal repairs are exposed are greater and of higher frequency than those acting on the left inguinal repairs—the right-sided musculature is normally more active and stronger than the left-sided musculature of the body. The recurrences in bilateral herniorrhaphies are no more frequent than those of right inguinal herniorrhaphies. This finding does not corroborate the usual conception that the probabilities of recurrences are higher in bilateral herniorrhaphies than in unilateral herniorrhaphies. As a matter of fact there is practically very little difference between the recurrence rate of bilateral herniorrhaphies and right sided herniorrhaphies in this series presented. The total recurrences in this series are so far 67 or 9.4 per cent, of the total 71 cases followed up. It is obvious that this percentage of recurrences will be higher if all the cases followed up had been followed for a period

SUMMARY AND CONCLUSIONS

1 An analysis of 711 herniorrhaphies performed in men between the fourth and fifth decades of life has been presented

2 The dissection and excision of all locules or peritoneal sacs is desirable to reduce the percentage recurrence following the repair of bilocular and direct hernias

3 Silk is the ideal suture in the repair of hernias and its advantages and disadvantages have been pointed out

4 The indiscriminate use of fascial strips does not decrease the recurrence percentage as compared with silk or chromic catgut when properly used

5 In 711 herniorrhaphies followed up there have been so far 67 recurrences, or 9.4 per cent of the total

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PULMONARY EMBOLISM

A Statistical Review of Cases from 1929 through 1938

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THE drama of medicine and surgery is all too frequently marred by the tragedy of pulmonary embolism. A complication which will enter into or cause the deaths of 3,068,000 (2) of the people now alive in the United States merits the serious consideration of the medical profession as a whole.

This study has been made to determine, if possible, in which patients this complication may be suspected, and also to find the common symptoms, if any that are present at the time of embolism.

In the period from 1929 to 1938 inclusive 94 cases of pulmonary embolism occurred or 0.184 per cent of the total admittances (Table I). Of these 104 followed surgery or 0.434 per cent of the total operative cases, and 90 or 0.394 per cent of purely medical cases.

One hundred and thirty-three of these cases came to autopsy that is, pulmonary embolism was found in 2.65 per cent of the deaths and in 4.35 per cent of all cases in which necropsy was done. Barker in reviewing all the cases of pulmonary embolism at the Mayo Clinic during a 13 year period, found that pulmonary embolism accounted for 5.9 per cent of all postoperative deaths.

Table II shows that in only 20 cases—13 surgical and 7 medical or 5.4 per cent of the patients coming to autopsy—had correct diagnoses been made.

The number of emboli occurring in each patient was determined by reviewing the histories very carefully particular attention being paid to observations recorded by the nurses. Fifty-four of these patients had shown evidence of previous emboli, which if recognized might have responded to some form of treatment and, in a fair percentage have avoided fatal outcome.

The number of emboli occurring in each patient was 1 in 40 patients, 2 in 26 patients, 3 in 19, 4 in 5, 5 in 6, 8 in 1 and 4 patients had multiple emboli. In the last 4 patients the emboli were not determinable from history but were found at autopsy. Of the 40 many survived the crisis for hours, and active treatment might have

benefited them. In only 45 of the 154 fatal cases did death occur in less than 1 hour. Fifty-five patients lived from 1 to 24 hours and 47 lived more than 1 day (Fig. 1).

The origin of the embolus could be determined either clinically or by autopsy in only 128 cases. Thrombi were found in the femoral veins in 75, with 39 on the right and 36 on the left. Mural thrombi were next in frequency occurring in 44 cases. The other sites are as follows: iliacs, 27; prosthetic plexus, 19; saphenous, 4; varicose veins, 4; site of trauma 6; pelvic veins, 3; miscellaneous, 3.

The site of lodgment of the embolus was most commonly in the pulmonary branch: the right lower lobe. Figure 2 shows the frequency in all parts of the pulmonary circulation.

ETIOLOGY

The etiology of pulmonary embolism is the etiology of venous thrombosis plus other factors in the individual which may predispose to the fatal outcome. Robertson, in analyzing 146 cases, found an average age of 44 years. There were 82 males and 64 females.

In our series of 194 cases, 96 were males of an average age of 57 years, 98 were females of an average age of 56 years, the average age of the entire group was 56 and a fraction years (Fig. 3). The most common age at which pulmonary embolism occurred was in the decade of 61 to 70 years, 46 per cent of this series occurred between the ages of 5 to 70 (Fig. 4).

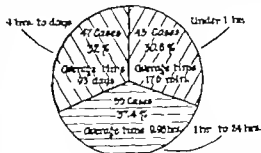


Fig. 4 Time interval between last embolism and death—47 cases

From St. Luke and St. Mary Hospitals
Presented before the Duluth Surgical Society March 6, 1940

TABLE I — ANALYSIS OF PULMONARY EMBOLISM CASES AT ST MARY'S AND ST LUKE'S HOSPITALS

	Cases	Per cent
Total admissions	105,284	
Surgical admissions	23,944	
Medical admissions	22,793	
Cases of pulmonary embolism		
All admissions	194	0.184
Surgical admissions	104	0.434
Medical admissions	90	0.394
Total deaths	5,019	
Total autopsies	3,056	60.8
Total pulmonary embolisms, clinical and autopsy	194	
Total emboli proved by autopsy	133	
Percentage of all deaths		2.65
Percentage of all autopsies		4.35
Proved clinically and autopsy	20	
Proved clinically but not autopsy	61	
Recovered	40	20.6*
Died	154	

* Of 194

TABLE II — CLINICAL DIAGNOSIS

	Autopsy		Clinical	
	No	Per cent	No	Per cent
Surgical	13	26.0	37	74.0
Medical	7	22.6	31	77.3
Total	20		68	

Nutrition Obesity is claimed by most reviewers to be a predisposing factor in the cause of pulmonary embolism. This, however, did not appear to be true in my series.

NUTRITIONAL STATUS

	Cases	Per cent
Entire group	194	
Above average (obese)	28	14.43
Below average (emaciated)	49	25.25
Average	61	31.44
Not stated	56	28.86
Surgical group	104	
Above average	12	11.5
Below average	21	20.1
Average	36	34.6
Not stated	35	33.6
Medical group	90	
Above average	16	17.7
Below average	28	31.1
Average	25	27.7
Not stated	21	23.3

An interesting observation of this small group is shown in Figure 5, which is interjected for its curious interest only, and most probably has no reason other than coincidence, unless the effects of business may react through the neurovegetative mechanism, thereby increasing the seriousness of what might otherwise have been a minor or overlooked episode (6, 9).

Crawford and Mohler claim that cardiovascular insufficiency favors embolism and is present in 50 to 95 per cent of the necropsies of patients dying as a result of this complication. In the 90 medical cases in my series, 61 per cent showed some form of cardiac pathology.

PATHOLOGICAL LESIONS

	Cases
Cardiovascular	
Cardiac—includes all cases in which cardiac pathology was primary or associated	55*
Coronary sclerosis and occlusion	19
Arteriosclerotic and hypertensive heart disease	18
Valvular	10
Myocardial	10
Thrombophlebitis	10
Decompensation	9
Auricular fibrillation	8
Endocarditis	2
Varicose veins	2
Peripheral vascular disease—arteriosclerosis	1
Cerebral accidents	4
Total	92
Infectious	
Typhoid fever	1
Parotitis	1
Undulant fever	1
Erysipelas	1
Bursitis	1
Total	5
Urologic	
Hypertrophy of prostate with obstruction	3
Kidney infections	3
Chronic nephritis and uremia	2
Cancer of bladder and cystitis	1
Total	9
Metabolic	
Thyrotoxicosis	2
Diabetes mellitus	1
Total	3
Gastro intestinal	
Hemorrhage	3
Carcinoma of pancreas	1
Carcinoma of bowel	1
Perforations of hollow viscous	1
Total	6
Miscellaneous	
Idiopathic epilepsy	1
Blood dyscrasias	2
Pelvic infection	1
Total	4

* 61 per cent of all medical cases

The type of operation no doubt is a big causative factor in emboli following surgery. Time

consuming and shocking operations through their physiological upset of the blood constituents, may contribute to thrombosis and ultimately to embolus. Major surgery is, however, not the only factor as in this series embolism followed a cataract operation phrenic excision, and the removal of a needle from the thoracic wall. Of the 104 surgical cases, 63 occurred after abdominal operations, 30 of which were in the upper abdomen.

SURGICAL OPERATIONS

	Cases
Head and neck	
Subtotal thyroidectomy	3
Phrenic excision and scalenotomy	—
Bilateral cataract	5
Total	—
Thorax	
Radical amputation of breast	4
Thoracoplasty	—
Removal of needle from thoracic wall	—
Pericardiectomy	—
Total	7
Upper abdomen	
Gall bladder and bile ducts	7
Gastric operations—malignant, 6 benign, 4	10
Esophagectomy (inoperable malignancy)	3
Total	20
Lower abdomen	
Appendectomy without drainage	7
Colonostomy (malignancy)	3
Hernias—inguinal, 3 femoral, umbilical, 1	—
Incisional	6
Appendectomy with drainage	—
Release adhesions	—
Resection of malignancies of large bowel	—
Total	—
Gynecologic	
Oophorectomy salpingectomy or both	4
Supravaginal hysterectomy	3
Fallopianctomy—malignant, benign, 4	5
Radiation treatment (malignancy)	—
Septic abortion	—
Retained placenta	—
Total	6
Urologic	
Transurethral prostatic resections	3
Suprapubic prostatectomy	—
Cystostomy	—
Nephrectomy	—
Aspiration of hydrocele	—
Total	3
Extremities	
Ligation or injection of varicose veins	—
Amputation of leg	—
Removal of semilunar cartilage	—
Arthroctomy	—
Total	3

Fractures

Neck of femur	4
Comminution of vertebrae	3
Ribs	—
Knee	—
Ankle	—
Os calcis	—
Pubis	—
Pathological, femur (sarcoma)	—
Shaft of femur	—
Skull	—
Shaft of tibia	—

Total

3

DIAGNOSIS

The diagnosis of a massive, sudden pulmonary embolism, which usually results fatally is not difficult. The diagnosis of the minor showers or single emboli challenges the clinician, if any thing is to be done to prevent the later larger and fatal emboli.

Various recurring painful areas in the chest unexplained low grade fevers for which the condition of the wound will not account, pain about the operative site out of line with the findings, and finally a nurse note that the patient is "very apprehensive" have all been noted as prodromal symptoms. These complaints should place one on guard that he is dealing with a potential serious embolism. Robertson found an unexplained low grade fever in 18 per cent of his patients while in this series this occurred in only 7 per cent.

FEVER INCIDENCE

	Cases	Per cent
Normal temperature curves	20	5
Low grade fevers	14	7
Septic temperature	23	3
Rise at or shortly after onset of embolus	9	6.0
A sharp degree of temperature rise at or after onset of embolus	—	05

In reviewing the charts in search of the symptoms to explain the time of lodgment of the embolus, it was noted that accompanying the increased pulse rate there was a rise in temperature. This occurred in 19, or 6 per cent of the series. There was an average rise in temperature at or immediately following the symptoms of dyspnea, cyanosis, pain etc., of 1.95 degrees. Usually these reactions subsided in 8 to 24 hours unless other complications ensued.

With the lodgment of an embolus of consequence symptoms of disaster are present. These usually are manifested by fainting, weakness, cyanosis, dyspnea, pain in the chest, hemoptysis,

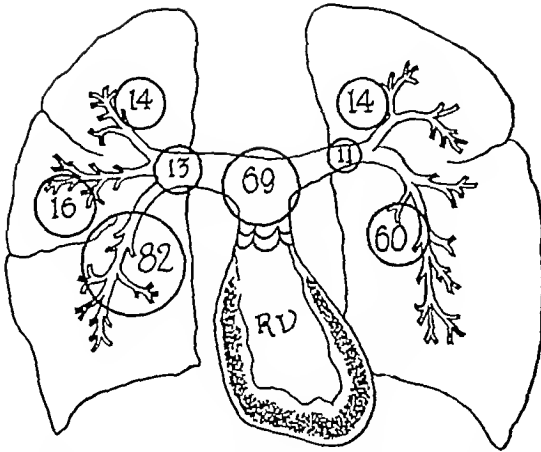


Fig 2 Site of embolus, determined clinically and by autopsy

or only grave fear of impending danger. These are usually accompanied by a rapid thready pulse, frequently cardiac arrhythmias, and extreme prostration. A fall in blood pressure is practically always present.

Immediate physical findings other than those already mentioned are nil. According to Robertson, if a main pulmonary branch is occluded, findings of pulmonary congestion soon develop in the opposite lung, due to the increased blood flow. If only one lobar branch is occluded, findings of congestion will be present in the other lobe or lobes of the corresponding lung. If there is a massive block of the main stem, immediate death ensues due to cerebral anemia. This is accompanied by collapse, syncope, pallor, and sudden death.

With the onset of pain, pleurisy may be complained of and diagnosed as such by the friction rub to be heard. Probably there will also be limited expansion on the affected side. Bloody sputum may occur early but is usually a later finding.

In the event a marked obstruction to the pulmonary circulation has occurred, evidences of acute dilatation of the right ventricle and pulmonary conus may be present, as stated by White. Peripheral venous dilatation, sometimes pulsation, may be noted. This is usually associated with marked accentuation of the second pulmonic sound due to the increased pulmonic pressure. Increased pulsations may be noted in the left second and third interspaces as well as a loud systolic murmur to be heard in this area.

Pulmonary infarction with its findings of complete or incomplete consolidation will occur later,

Sex 194 Cases

Total Male	96	Medical	48	Surgical (incl. trauma)	48
Total Female	98	Medical	46	Surgical (incl. trauma)	56

Average Ages

Entire Group	
Males	
Females	
Surgical Patients	
Medical Patients	
Male Surg. Pts.	
Female Surg. Pts.	
Male Med. Pts.	
Female Med. Pts.	

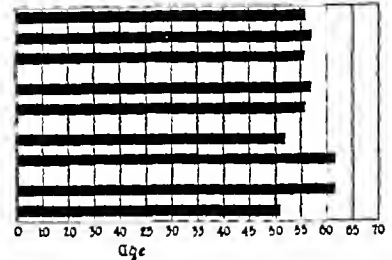


Fig 3 Sex and age incidence

only if there be some impedance to the return venous flow of blood (4).

In patients who have exhibited minor symptoms of emboli, search should be carefully made for the slightest evidence of thromboses. O'Ware (8) has found characteristic tenderness of the sole of the foot accompanying thrombosis of the foot or leg. Abdominal, prostatic, and uterine veins produce few or no symptoms but psychic apprehension, vague undefinable discomforts in the abdomen or legs frequently precede the occurrence of embolism. Robertson advises that in these patients a definite effort be made to determine whether or not they are "thrombophiles." He states that if the clotting time of the blood is shortened after the fourth postoperative day or at any time during convalescence, it is suggestive of thrombosis. The platelet count may be of value in determining a "thrombophile" if done by one experienced in this work. He states that if the platelet count falls below normal and continues low, a thrombus may be developing. Lastly, an accelerated sedimentation rate after the normal postoperative expectancy (young patients, 8 to 10 days, older, 10 to 20 days), should be regarded with apprehension.

Roentgen-ray diagnosis of pulmonary embolism has been not only unsatisfactory but detrimental to the patients in this group. Roentgen-ray diagnoses had been made on 51 of these patients who later came to autopsy. Diagnosis of pulmonary embolism questioned was made on 1 patient.

Roentgen-ray diagnoses in 51 autopsy proved emboli were as follows: passive congestion, 10, negative, 9, slight bronchopneumonia, 7, suspected pneumonia or bronchitis, 6, increased bronchovascular markings, 4, thickened pleura or fluid, 4, atelectasis, 2, consolidation, 2, haziness, 2, miscellaneous—singulans, 4, pulmonary embolism (?), 1.

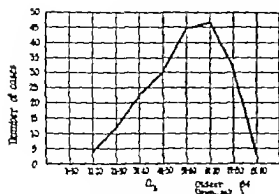


Fig. 4. Age incidence—94 cases.

Differential diagnosis. The condition most commonly confused with pulmonary embolism is acute coronary occlusion. A mistaken diagnosis in these conditions will not, as a rule, do any harm to the patient because the treatment for one is good treatment for the other and logical treatment for either can in no way harm the other. In coronary occlusion the pain is usually much more severe than in embolism and is more frequently referred to the central regions. The pain of embolism, when present, is usually around the costal margins or laterally in the chest. It is usually aggravated by respiration while that of coronary disease is not affected. Dyspnea and cyanosis are usually more marked in coronary occlusion. The other symptoms of fainting, shock, weakness, sweating, collapse, vomiting, etc., are common to both conditions. The history of anginal attacks, dyspnea or other symptoms of cardiac disease may assist. White McGinn and White and corroborated by Barnes have shown that distinct characteristic electrocardiographic changes take place in both conditions, and when there is a question as to diagnosis, this procedure should be valued. Barker states that he believes that the electrocardiogram is the most valuable diagnostic procedure when a pulmonary embolus is present.

Spontaneous pneumothorax should be readily differentiated by the rather marked physical findings in the chest, shifting mediastinum and finally a roentgen-ray examination of the chest, if deemed absolutely necessary, should clinch the diagnosis.

Atelectasis usually occurs sooner after periods of unconsciousness and though the symptoms are frequently the same as in embolism the severe early cough, the lack of pleural pain, the absence of pulmonary artery back pressure and finally

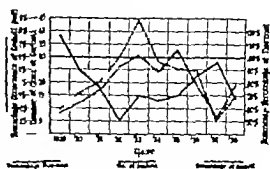


Fig. 5. Occurrence of pulmonary embolism in relation to business activity.

the roentgen-ray may all assist in making the diagnosis.

The diagnosis of postoperative or hypostatic pneumonia should never be made until pulmonary embolism is ruled out. In my opinion many of the so called postoperative pneumonias are primarily emboli later developing pneumonic findings. The treatment of pulmonary embolism will in no way interfere with what pneumonia should have and if a frank pneumonia is developing the diagnosis should be clear after 24 hours has elapsed and no time will have been lost to the most hazardous embolism.

Pleurisy with its usual pain, friction rub, mild fever, etc., should always be regarded as evidence of embolism in older postoperative patients or in medical cases presenting symptoms of impaired circulation.

TREATMENT

The treatment of pulmonary embolism has been very well covered in the literature and hence will not be reviewed in this article. A brief summary of important points, however, might not be amiss.

The preventive treatment should be directed toward the prevention of stagnation to the return flow of blood. This can be accomplished by active and passive exercises, hyperventilation, maintenance of blood pressure level, and preventive or active treatment of ileus. Dietary influences on the coagulation of blood may enter into the predisposition to thrombosis and ultimately emboli. Kugelmann, Mills, and Clark (8) have all shown that the low fat, low protein diet is the least conducive to thrombotic changes, and recently gelatin has been found to lower rather than mark the bleeding and coagulation time of patients submitted to tonsillectomy (7). It has been stated by some authorities (1) that when heparin is used by continuous intravenous drip thrombosis will not occur.

Active treatment will depend upon the recognition of the minor symptoms of small emboli, thereby being prepared to meet the major crisis. Oxygen should be immediately available. Sterile syringe, needle, and tourniquet together with a solution containing $\frac{1}{2}$ grain of papaverine hydrochloride should be in the room for immediate intravenous administration (3, 5, 6). This should be followed by injections of fairly large doses of morphine and atropine. The patient should be in unceasing attendance by an intelligent nurse. On this regimen one of our patients recently recovered from what appeared to be a large embolus.

SUMMARY

A statistical review of the cases of pulmonary embolism occurring in 105,284 hospital admissions has been given.

Etiological and pathological findings as they may enter into pulmonary embolism have been given from a statistical standpoint.

Accompanying the usual symptoms of pulmonary embolism an average rise of temperature of 1.95 degrees was found in 61 per cent of these patients.

X-ray diagnosis of pulmonary embolism is not only unsatisfactory but detrimental to the patient's welfare.

Electrocardiographic tracings are a valuable procedure in the diagnosis of pulmonary embolism.

Careful study and observation may lead us to the determination of the type of patient predisposed to pulmonary embolism, and it is to this end our efforts in the future should be directed.

Prophylactic treatment of active exercises, massage, prevention of acidosis, the use of heparin, psychic relaxation, and dietary control may avoid emboli.

Active treatment with antispasmodics and sedatives offers some hope after the crisis has occurred.

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VITALLIUM NAILS IN FRACTURES OF THE HIP

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THE solution of the unsolved fracture is gradually unfolding and the essential features of its treatment are agreed upon with the exception of the type of metal device used for fixation. Whitman's method of reduction, described in 1904, has become universally recognized as a standard procedure. The fixation of hip fractures with metal appliances has been well worked out by Smith-Petersen, Moore Martin, and many others. The technique of exposing the fractures and inserting the fixation devices is becoming more simplified and less subject to error. The criteria of proper postoperative care and protection of the fractured extremities are coming to be agreed upon by most surgeons. In short, most of the steps in treatment of fractures of the hip have become well enough established that there is little disagreement about them.

One remaining source of argument in this matter concerns the choice of metal alloys of which the various nails are made, and it is this which we hope to clarify in our present paper. For 3 years we have been experimenting and reporting our findings on the reaction of bone to metals (24 to 28). Over and over again we have demonstrated that most metals commonly used in bone surgery produce destructive electrolytic effects which cause the appliances to loosen. There is yet much confusion over the causes of failure when metal nails in the hip become loose and ineffective. For instance many surgeons have observed that collections of fluid accumulate about the ordinary steel nails, the surrounding bone becomes eroded and the nails become loose and quite insecure in a comparatively short time (Conwell and Sherrill, Henderson, O-1 Watson-Jones, Campbell, Gaenslen, MacAnaland, Bonworth). This is usually blamed on infection, pressure necrosis, foreign body reaction or faulty technique which throws undue strain on the bone.

It is our observation that nails become loose (in the absence of infection or technical faults) because of electrolytic activity between the constituent metals in the alloy which is sufficiently intense to destroy adjacent bone. The amount of erosion we have found depends upon the constituents of the alloy and their resistance or relative passivity to electrolytic activity in the body fluids. Nickel or chromium plated steel nails cause marked de-

struction of bone because of the galvanic cell action of the dissimilar metals. A single unplated nail of so called stainless steel is composed of many metals, such as iron, chromium, nickel, etc., and the electro-activity between them, which can be demonstrated with a microammeter will cause bone to be corroded about the nail. Fluid accumulation which seems to indicate infection is more often a body reaction against the local irritation. Cultures of such fluid are in variably negative but chemical examinations usually reveal evidence of metals in solution.

A number of men have removed nails from the hip and noticed that they were eroded and discolored while the adjacent bone was stained with deposits of metal pigments (Campbell, Harris, Speed, Kulowski, Raagaard). Such extensive destruction of metal was ascribed to chemical corrosion or to defective preparation of the nails. It is a striking proof of the intensity of electrolytic activity that it can not only erode bone but cause a metal nail to disintegrate in the body fluids (Figs. 1-3). In our experiments, chemical analyses of bone specimens from the neighborhood of such metal appliances revealed the presence of particles of the constituent metals of the alloy. Moreover examinations of the livers and kidneys of experimental animals were also positive for evidence of deposited metals.

It has been pointed out by Harris and Jones and Lieberman that the terms "rustless steel" and "stainless steel" are used to describe many ferrous alloys of widely dissimilar composition. They state further that most surgeons are not qualified to determine the suitability of a proposed alloy for use in the body and are therefore at the mercy of instrument salesmen or must depend on the recommendations of surgical catalogs.

Alloys of various composition have been recommended as suitable for bone surgery and their proponents have stated that they caused no erosion of bone but tests for electrolytic activity have seldom been performed. Stainless steel (Moore) monel metal (Henderson) chrome steel (Carothers) chrome-nickel steel (Flummer) low tempered tool steel (Lippman) and many more have been utilized in the body with varying degrees of success. We have found that many of these alloys were sufficiently electro-active to pro-

duce a marked current when connected with a microammeter. Also when some of the metals were placed in physiological saline for a short time, chemical examination of the fluid revealed evidence of constituent metals in solution. Consequently, we hesitate to recommend an alloy for use in the body when such proofs of electrolytic activity are demonstrable. For this reason we introduced the non-electrolytic alloy vitalium into bone surgery since it was the only one which quickly became permanently passive in the body.

Raagaard, of Denmark, and Harris, of Toronto, were of the opinion that corrosion of nails and surrounding bone was directly affected by the finish of the nails. They inferred this by pointing out that the more rapid disintegration of metals took place in screw threads or near the ends of the nails. We have likewise observed this but we have seen that corrosion will not take place at any point in a piece of non-electrolytic alloy. *In other words when an alloy is non-electrolytic there are no anodic or cathodic points where currents are initiated.* Our views of this question can be better explained by a brief description of the phenomena of electrolysis about metal appliances.

HOW ELECTROLYSIS TAKES PLACE

Corrosion of metal is preceded by electrolysis and electrolysis can take place only in the presence of *moisture*. It is to prevent this that exposed metal is painted. Oxidation furthermore can take place only after electrolysis and corrosion have begun. For instance, Masmontel points out that the hulls of hydroplanes, although made of corrosion-resistant alloys which would not tarnish, were subject to electrolytic reaction when in an electrolyte like sea water. Also it is a familiar observation of those living near the sea that salt

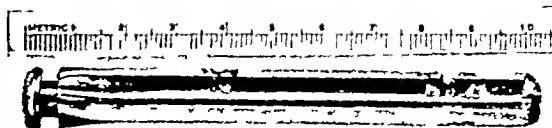


Fig 1, top. Photograph of steel nail removed from patient by Kellogg Speed. There had been pain, erosion of bone, and absence of union. Note electrolytic disintegration of metal which was sufficient to destroy bone about the nail.

Fig 2. Photograph of nail of high chromium, high nickel stainless steel, removed by R. I. Harris. Electrolytic activity which corroded the nail caused marked destruction of bone and formation of "sterile abscess" in the wound.

spray causes rapid disintegration of exposed metals. Dissimilar metallic ions must be in close proximity for electrolysis to take place. This does not necessarily mean that two separate pieces of metal must be in contact because the presence of dissimilar metallic ions in an alloy will be sufficient stimulus to set up local currents. Of course, an appliance made of a single chemically pure metal would not be subject to electrolysis when immersed in saline but metals free of impurities are quite expensive and far too soft to be made into screws or nails. In the common alloys, ions of the different constituent metals are scattered about helterskelter so that each mass of particles forms a tiny battery with the adjacent dissimilar particles and gradually produces irregular destruction of the surface comparable to "pit corrosion."

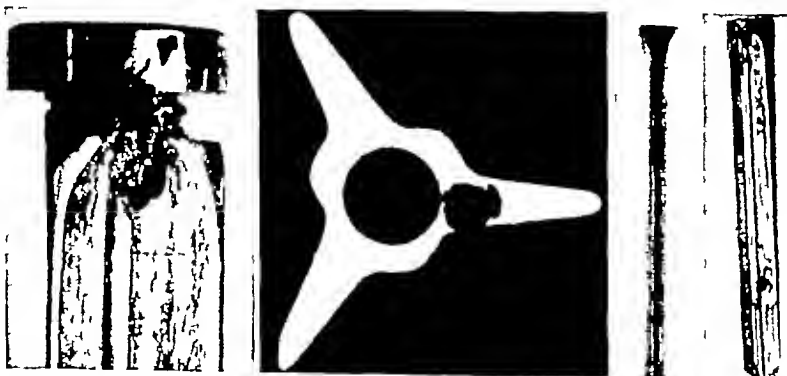


Fig 3. Photograph, roentgenogram, and cross section of rustless steel nail removed by Otto Raagaard. Electrolytic destruction of metal and bone caused nail to loosen sufficiently to prevent union of fracture.



Fig. 4.

Fig. 4. Mrs. D. N. C. Fracture of left hip anchored with Hallgren screw. Roentgenogram taken 3 months later shows solid bony union. It shows no evidence of reaction about the screw.



Fig. 5.

Fig. 5. Mrs. G. H. Fracture of right hip fixed with Hallgren Smith-Petersen nail. Roentgenogram 3 months later shows secure attachment of nail to bone. It shows no erosion about it. Fracture solidly healed.



Fig. 6.

Fig. 6. Mrs. H. J. aged 63 years. Fracture of right hip which was treated with Hallgren Smith-Petersen nail. Roentgenogram 5 months later shows solid bony union of the fracture. It shows no changes about the nail.



Fig. 7.

Fig. 7. Miss E. F. aged 63 years. Fracture of right hip secured with Hallgren Smith-Petersen nail. Roentgenogram which was taken 4 months later reveals good union of the fracture.

Electrolysis of metals is accelerated if the molecular arrangement of the alloy is altered by certain physical forces. Thus if a plain carpenter's nail is bent and placed beside a similar straight nail in saline the bent nail will corrode more rapidly and break at the point of bending where there is produced continual anodic-cathodic action. A piece of an electrolytic alloy of rough finish or a piece with many irregular surfaces and corners will corrode more rapidly in an electrolyte than will similar articles of the same alloy which are highly polished.

Corrosion, rusting, oxidation, and the more familiar end-stages of the disintegration process are preceded by electrolytic activity between the constituent ions of an alloy. Consequently metals used in the body where they are bathed in a salt solution 24 hours a day must be non-electrolytic if they are to resist corrosion.

HOW ELECTROLYSIS CAN BE PREVENTED

Since metal appliances used in the body cannot be kept dry and since they cannot be constructed of a single pure metal, we have sought an alloy that would be sufficiently strong and yet free of any electrolytic activity in body fluids. Recently it has been brought to our attention that Masmonetti, of Saint-Ouen, had arrived at these same conclusions and had stated that metals suitable for bone surgery must be biologically inert, i.e. free of organisms, mechanically inert, be placed in a proper position on the bone, chemically inert, containing no injurious substances and

physically inert, or free of electrolytic activity. Of the various alloys he tested none satisfied all the postulates. The solution, concluded Masmonetti, *C'est le secret de demain*.

Berti-Riboli, of Genoa, has likewise found that metals which erode bone in experimental animals are the ones with the most electromotive force. On the other hand, the metals with least electromotive force, such as 20 carat gold, produced less toxic effect on the bone than any others.

We have found that alloys which produce appreciable current on the microammeter will cause erosion of bone in experimental animals. Conversely an alloy like titanium which produces little or no current on the microammeter can be placed in bone without danger of the pathological reactions which Masmonetti has called electrolytic osteitis.

TITANIUM ALLOY

In 1936 we reported animal experiments which showed that electrolysis was the important factor in the use of metals in bone and that the alloy titanium seemed to be inert in human bone (5). Since that time appliances made of titanium have been used in various ways by many surgeons, including Smith-Petersen, Campbell (5), Badgley and others, with no case of erosion of bone about the metal appliances.

I have 20 patients in whom we placed titanium nails in the hip more than 6 months ago. There has not been any evidence of loosening of the nails or erosion of bone. Eighteen of these patients



Fig 8a

Fig 8b

Fig 8 a, Mrs W D B, aged 60 years Fracture of right hip treated with vitallium Smith Petersen nail Nail was too short and did not secure good hold on capital fragment, b, 3 months later, adduction deformity and displacement of head of femur, c, 8 months later, after nail had been re-



Fig 8c



Fig 9

inserted in head Solid bony union, no reaction about nail

Fig 9 Miss A B, aged 76 years Fracture of left hip treated with vitallium Smith Petersen nail Roentgenogram 1 year later shows firm union with no evidence of erosion about the nail

achieved solid rapid bony union and no interference with healing of the bone In 1 patient the nail pulled out of the head of the femur because it was not placed sufficiently deep Even so, it was re-inserted, the fracture healed, and the nail is still tightly implanted in the bone (Fig 8) The one failure was a similar case in which the nail engaged the head insufficiently and the fracture pulled apart several months after the operation as the patient was getting in a car This nail was removed and the patient developed a complete non-union of the fracture

In none of the cases did the wound fail to heal promptly and no fluid accumulated in any hip Of the 20 patients, 19 attained bony union and the 1 failure in this series was due to a technical fault in the insertion of the nail Over a period of many months no late complications have developed in any case due to the presence of the metal nail (Figs 4 to 9)

Vitallium is an alloy of cobalt, 65 per cent, chromium, 30 per cent, and molybdenum, 5 per cent, which seems to be completely passive in the tissues It is hard, non-malleable and at first was not strong enough However, we believe that this material has now been toughened sufficiently to be comparable in strength to any of the steels Nevertheless we know of no instance in which a vitallium hip nail has cracked or broken in the hip A single vitallium nail will support 500 pounds in a power tester without bending Appliances made of this alloy must be cast, since it cannot be machined

On the favorable side, we find that vitallium produces no appreciable current on the micro-

ammeter, it is not affected by submersion in saline, and it is electrically passive in the body fluids Appliances made of vitallium can be used in the body with perfect safety and can remain in the bone indefinitely without the usual haunting fears of the occurrence of late complications Vitallium screws and nails do not loosen in bone, no fluid forms around them, and normal body healing processes are in no way delayed by the presence of the metal

Undoubtedly, other equally inert metals will be developed which may be more adaptable to bone surgery We hope so, and we will pursue our experiments in order to test any new alloy which comes to our attention Our conviction is that the ideal metal developed by the orthopedic surgeons of tomorrow must meet our qualifications of complete absence of electrolysis in body fluids, negative readings by microammeter test, and absolute inertness in experimental animals or in experimental batteries Certainly any appliance as large as a Smith-Petersen nail which gains its advantage by surface hold on the bone must be constructed of a non-electrolytic alloy Vitallium nails meet these requirements more perfectly than any we have encountered in our experimental work thus far

Other tests are under way because one of us (C S V) is working with the Fracture Committee of the American College of Surgeons in a search for the most suitable alloy for use in bone surgery Whatever is the final choice, we think we have proved that no metal will remain inert in bone unless it is at first and continuously thereafter electrically passive

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THE RESULTS OF SURGICAL TREATMENT OF RECURRENT INGUINAL HERNIA

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NUMEROUS operative procedures have been devised for the correction of inguinal hernias, and in their evolution much progress has been made. However, we still have no right to assume a too complacent attitude since the number of recurrences following primary repair, as reported by different authorities (4, 5, 8, 13) upon careful follow-up, varies from 5 to 20 per cent for indirect hernias and 20 to 30 per cent for direct hernias. This is too high. Yet it should not be a deterrent, on the contrary the recognition of this fact should serve as a stimulus to examine meticulously the various factors in the techniques used in an effort to overcome, replace, or reinforce the structural weaknesses that might exist.

This paper is based upon a study of 130 recurrent hernias in 115 patients who were operated upon between January, 1935, and April, 1938. In this series, 109 were primary recurrences, 11 secondary, and 10 tertiary recurrences. The kind of defect in the wall, the technique and type of sutures used, the percentage of follow-up cases at yearly intervals, and the number of recurrences following our operations are discussed and tabulated. From an analysis of these data the main causes of failure of the original repair of the recurrences were as follows: (1) incomplete removal of all locules of the sac, (2) overlooked diverticula, (3) failure to recognize weaknesses of the wall, (4) unphysiological repair of the wall.

1. *Incomplete removal of all locules of the sac.* During one's didactic and early surgical training, too much emphasis is placed upon the textbook classification of hernias, i.e., indirect, direct, and femoral, which in reality represents the end stages of the hernias. Actually many hernias cannot be so classified and any attempt in this direction may cause confusion. However, when the sac is considered in its incipiency as an offshoot of peritoneum which by increased intra-abdominal tension pushes its way through a weakness or defect in the muscular and the all important posterior fascial wall (internal ring, inguinal triangle, and femoral ring), the sequential development of one or more locules of the sac through

the concomitant weak points is easily understood. This consideration simplifies and makes much easier the correlation of the findings at operation. Moreover, by systematic approach to the peritoneum at the internal ring where there is almost invariably some bulging, there is less likelihood of becoming confused by the distorted structures. When the peritoneum is opened and the index finger is introduced one is able to diagnose accurately the number of locules, their size, location and relation, and to evaluate the extent of the fascial and muscular weakness.

It has been our contention that the locules of the sac play a more important rôle in the etiology of recurrent hernias than is generally accorded them. In this series of 130 recurrent hernias the types of sacs found are shown in Table I.

These statistics therefore bear out the consensus, which is supported by many published reports, that most recurrent hernias are direct. In recurrent hernias the ratio of direct to indirect sacs is 8:1, whereas in primary hernias the ratio of direct to indirect sacs is 1:5. The chief reason for the former is that the direct portion of the sac was not recognized and not removed at the initial operation. The bilocular sac, which consists of both direct and indirect locules, appears with increasing frequency in patients past middle age, and is concomitant with a dilated internal ring, diminished muscle tone, and insufficiency of the fascia transversalis. This type is more prone to occur in hernias of long standing. Much to our surprise the diverticular type had an incidence of 13.8 per cent and since it is so easily corrected, one can reasonably assume that its presence was not suspected at the time of the original repair. Therefore, we feel that this type of diverticular

TABLE I — TYPES OF SACS IN RECURRENT
HERNIAS

	Number	Per cent
Direct	71	54.7
Indirect	10	7.7
Bilocular	27	20.7
Diverticular	18	13.8
Hernia adiposa	2	1.5
Sliding	1	.8
Trilocular	1	.8

From the U. S. Veterans Administration

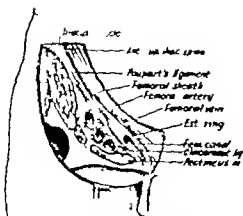


Fig. Sagittal section slightly distal to Poupart's ligament demonstrating the anatomical relations of the principal structures.

defect is not receiving the importance it should as an etiological factor in the development of recurrent hernias.

If routine digital exploration of every sac is practiced to discover possible peritoneal fistulas, this type of recurrence could be reduced. While quite rare a trilocular sac, indirect-direct femoral occurred once in this series and in this case there was marked generalized diminished muscular tone and a dilated femoral ring. Hernia adiposa or fatty masses were noted twice and these could not be differentiated from true herniations prior to exploration. Sliding hernia which was not accurately diagnosed before operation was present once.

2. *Overlooked diverticula* Andrews and Bissell (4) in 1934 directed attention to diverticula and the part they played in direct hernias. They pointed out diagnostic maneuvers for their detection and introduced plastic corrective measures. The incidence of diverticula in direct primary hernias is reported as less than 10 per cent, while the incidence in our series of recurrent hernias was 3.8 per cent. These diverticula were exclusively responsible for the clinical manifestations of the hernias. Of greater importance, every recurrent diverticular hernia should be considered a diagnostic and not an operative failure as the elimination of the sac and correction of the defect is such a simple yet secure procedure that a recurrence is hardly likely. In reviewing our records it has not been clear at times whether the outpouching was a part of the direct sac or a diverticulum which communicated through stalk. This confusion however did not obtain in the other type of diverticulum in which there

was a distinctly isolated non-communicating endothelium lined locule. If the diverticula were limited to the latter it would be conducive to more accurate statistics regarding this type of hernia.

3. *Failure to recognize weaknesses of the wall* The cumulative evidence of a decade or more supports the indictment that too often there is a failure to recognize weakness or absence of the transversalis fascia.

TABLE II.—MURAL WEAKNESSES

	Number	Percent
Relaxation of fascia transversalis	77	50
Attenuation of fascia transversalis	50	31.6
Absence of fascia transversalis	8	6
Absence of Poupart's ligament	4	3
Large femoral ring	3	2
No weakness found, fatty masses		8

In Table II is shown the classification of various mural weaknesses found in this series of recurrent hernias. By relaxation of the fascia transversalis is meant slight bulging of the entire floor due primarily to diminished tone in contraction due to attenuation of the fascia in which there is definite thinning of this structure. It is conceded that there may arise at times differences of opinion in interpreting these two types of weakness. However this distinction is important because it calls for technical variations in the repair of the floor of the canal.

In those cases in which the fascia transversalis is missing, it is unmistakable as there is no resistance offered to the bulging peritoneum. Usually these hernias are huge and frequently the patient has undergone many unsuccessful operations. It is in this type of weakness that a radical hernioplasty is indicated.

A frayed Poupart's ligament is usually associated with absence of fascia transversalis but this is by no means constant. If this ligament is so elastomous, so fragile, and its help so narrowed that it no longer offers substantial anchorage then Cooper's ligament (Fig. 1) should be exposed and used in lieu of it.

A large femoral ring should be recognized and if not obliterated it is a potential source for a recurrence particularly when the peritoneum is attenuated. Therefore we feel that the type of mural weakness is a better criterion than the sac in determining the most suitable operative procedure.

4. *Physiological repair of the wall* By physiological repair of the wall is meant an attempt to correct the defect in the all important fascial floor by utilizing tissues which are not histologically or physiologically related. The

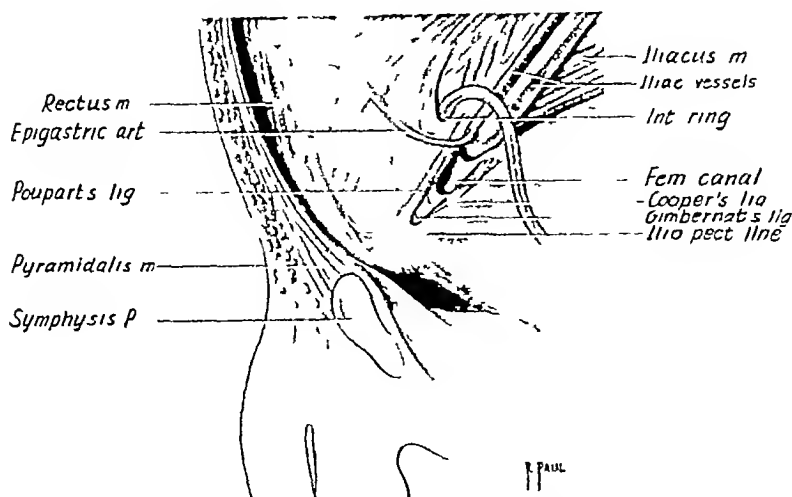


Fig 2 Posterior inner view of the abdominal cavity minus the parietal peritoneum showing the anatomical relations of the principal structures covered by the inguinal canal floor. Notice the relations of Cooper's ligament to the femoral ring and Gimbernat's ligament

experimental and clinical work of Andrews, Koontz, Gallie, LeMesurier, Seelig, Turner, Wangenstein, and others should convince the most skeptical that strong fusion takes place only when white fibrous tissues are apposed and that muscle tissue as an auxiliary reparative measure produces no lasting adherence and is worthless in so far as contribution to the formation of a strong supportive floor is concerned. The most frequent error of this nature is the suturing of the internal oblique muscle to Poupart's ligament without regard to the observations of Andrews and Bissell (4), which recently have been corroborated by Anson and McVay, that this muscle is neither constant in its insertion nor in its muscular and aponeurotic components. Therefore, if this muscle is used as a lamina in the repair of the hernia, the resultant union to the ligament will not be strong.

When the insertion of this muscle in the rectus sheath is some distance from the pubic spine the joint actions of these muscles tend to tear away the oblique muscle attached to Poupart's ligament. This simply would leave the wall structurally as it previously existed except perhaps for the removal of the sac. With the realization of this anatomical and physiological principle there has quite naturally followed a retinue of operations the object of which is to accomplish an exclusive fascial closure. When there is a simple dome-like convexity of the fascia transversalis without any attenuation with associated enlarged atonic internal ring, the defect can be corrected by attaching

the fascia transversalis to Poupart's ligament. However, if this produces undue tautness or if there is marked attenuation of this fascia, then it becomes necessary to resort to fascial sutures. In the event Poupart's ligament is lacking or is friable, which is more likely to occur after repeated operations, it is suggested that the fascial lamina be attached to Cooper's ligament (6). If there is absence or retraction of the transversalis fascia so that it cannot be made to span the defect in the floor, a pedicle fascial graft may be brought up through the femoral canal, fanned out, and sutured to the lateral margins of the sheath of the rectus, thus replacing the transversalis fascia and making a deeply placed mural lamina. This technique will be discussed later in this article.

OPERATIVE PROCEDURES USED AND INDICATIONS

1 Routine repair (11) The method described by us in a previous communication consists in attaching the cleaned fascia transversalis to the shelving border of the inguinal ligament with imbrication of the aponeurotic flaps beneath the transposed cord. A strong fascia transversalis and inguinal ligament must obtain for success of this method. The sac in this technique as well as in the other techniques is dealt with by the excision of all locules and the use of a purse-string suture in the stump. The results following this technique have been very satisfactory. There have been 75 per cent recurrences in 457 primary hernias and 14 per cent recurrences in 64 reoperated upon recurrent hernias.

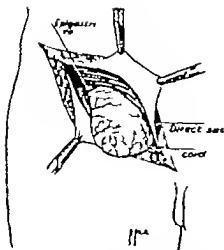


Fig. 3 Appearance of the inguinal floor in direct hernia in which the fascia transversalis is entirely missing.

2. *Fascial sutures* (Gallie and McArthur). When marked relaxation of the floor is present with loss of support in the inguinal triangle because of attenuation of the transversalis fascia, associated with dilated, incompetent internal ring and diminished muscular tone, strips of fascia lata have been used to reinforce the transversalis fascia and to insure more certain union. If only one suture is considered adequate a strip is taken from the aponeurotic edge as has been suggested by McArthur. In 25 recurrent hernias followed 3 or 1 per cent, recurred.

3. *Attachment of transversalis fascia to Cooper's ligament* (6). In cases in which a locule of the sac protrudes into the femoral canal, a femoral hernia, or in which Poupart's ligament is shallow with narrow shelving portion, it tends to tear easily; the transversalis fascia should be attached to Cooper's ligament by silk or fascial sutures. Of course when this technique is used the fascial components must be competent. In 7 hernias repaired by us by means of this technique there has been 1 recurrence, or 14.3 per cent.

4. *Pedicle fascial graft* (modified W. Gowstein). This operation is a much more formidable procedure than the ones heretofore described and has been employed only in the large intractable hernias in which other more conservative procedures have been unsuccessful. The majority of the patients in this group had been previously operated upon two or three times and had become pretty well reconciled that further operative attempts would be useless. Furthermore some of the patients had been divided by surgeons of

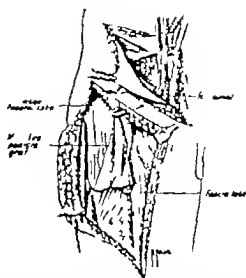


Fig. 4 First stage in the mobilization of the mesh-pedicle fascial graft obtained from the fascia lata. Notice that in this graft is also included part of the tensor fasciae latae. The curved hemostat has been passed through the femoral canal into the subcutaneous adipose layer ready to transpose the graft into the inguinal region.

wide experience that their hernias were irreparable. Fortunately these difficult hernias occurred only 8 times in our series of 130 recurrent cases, an incidence of 6.0 per cent.

On examination of the inguinal region one finds a huge hernia usually containing coils of intestines which is easily reduced. On palpation there is noted an elongated oval defect in the wall just medial and parallel to Poupart's ligament, admitting perhaps three or four fingers without meeting any supportive structure in the floor. The all important fascia is not demonstrable. At operation after the muscular and fascial planes are mobilized it is quite obvious that the fascia transversalis is either missing or perhaps only a medial remnant of it is left so that it can no longer be made to span the defect by suturing it to the inguinal ligament. Then too in these large and usually long standing hernias there is concomitant general relaxation and weakness of all the tissues in this region. The latter are secondary contributing factors that must be included in appraising the indications for a radical hernioplasty.

TECHNIQUE OF OPERATION

After the scar in the inguinal region is excised the sac is evacuated of its contents (Fig. 3). All

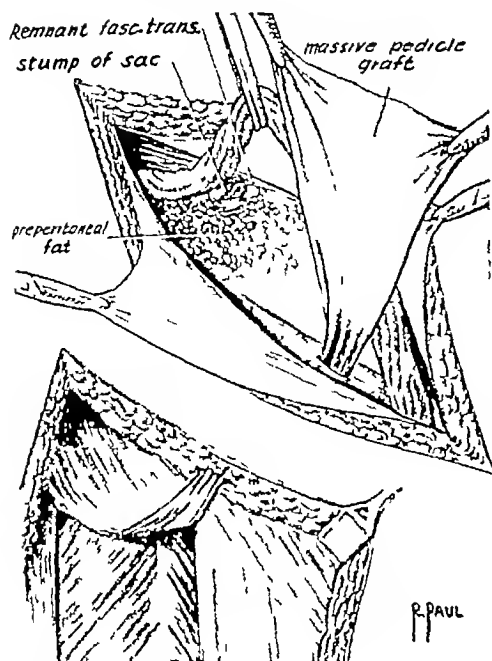


Fig 5 Second stage in the mobilization and transposition of the graft. The graft has been already transposed into the inguinal region via the femoral canal.

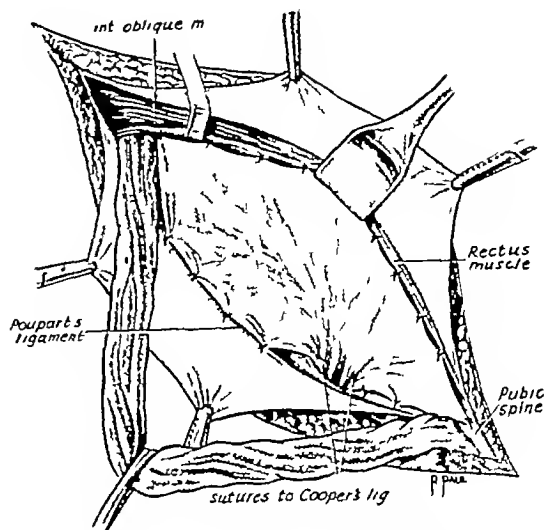


Fig 6 Last stage in the fixation of the graft to supplant the missing fascia transversalis. Notice the deep stitches fixing the graft to Cooper's ligament.

toneal fat, and the smooth, glistening, deep surface becomes apposed to the fascial and muscular lamina. The aponeurotic flaps are then overlapped beneath the cord (Fig 7). No attempt is made to close the fascial defect in the thigh.

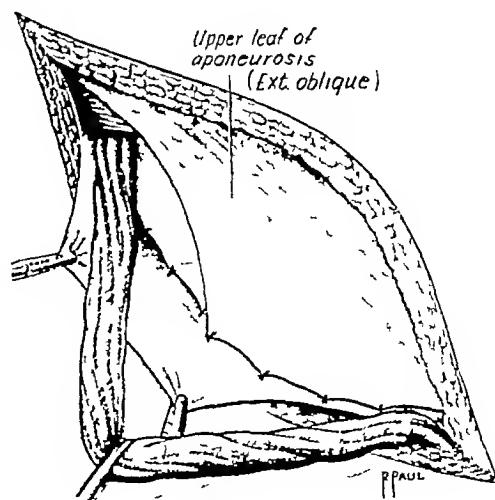


Fig 7 Further stage in the repair of the hernial defect. The upper flap of the aponeurosis of the external oblique has been attached in part to the shelf and oversheaf of Poupart's ligament. In large defects this might not be possible.

locules are freed, converted into one, and the wall of the bladder, which is usually adherent, is dissected away, thus permitting high ligation of the sac. The muscular and fascial planes are then identified, and the cord is mobilized so that a clear picture of the extent and cause of the defect is evident. The next step is to raise a flap of fascia lata 5 to 6 centimeters in width. Up to this point the details have been identical with those described by Wangenstein (Fig 4), but at this juncture they differ from the latter in that a curved forceps is carefully insinuated through the femoral canal (Figs 1 and 4), grasping the fascia and drawing it through the canal (Figs 1 and 5), without rotating it, to avoid any circulatory impairment which might interfere with its viability. The fascia is then fanned out and sutured to the margin of the defect (Fig 6), i.e., remnant of transversalis fascia, the transversalis and internal oblique muscles opposite the internal ring at the exit of the cord and laterally to the deep shelving portion of the inguinal ligament and to Cooper's ligament (Figs 2 and 6) at the posterior arc of the femoral ring. Thus the surfaces of the transposed graft assume a converse relation. The superficial side which may have a few attached fat globules comes to lie in contact with the preperi-

Because of the large area of denuded and exposed tissue, rigid asepsis and meticulous hemostasis must obtain as infection or the formation of a hematoma would seriously jeopardize a favorable outcome.

The advantages of the modified Wangensteen technique are (a) the pedicle fascial graft is more deeply placed, occupying the same an anatomical level as the former fascia transversalis (b) it reaches this position through normal patient canal without compromising the function of the inguinal ligament and (c) it obliterates the femoral canal which prevents any chances of the formation of a femoral hernia.

In our series this type of repair has been performed fifteen times. Seven of these have been done during the past year so that only 8 are included in the follow-up. The original Wangensteen technique was followed in the first 3 cases, bringing the pedicle flap over the inguinal ligament. However it seemed to us that a more secure wall would be obtained if the flap were more deeply placed. Accordingly 6 operations were done in which the femoral canal was used as the passageway for the fascial flap. In this group there has been one recurrence which occurred in the original or anterior flap transposition but thus far there have been no recurrences in those cases in which the transfemoral canal method was used. Infection occurred in one case which drained for several weeks until the silk sutures were extruded but this did not preclude the obtaining of strong wall. In none of the cases in this group has there been hemorrhage, thrombophlebitis or any demonstrable circulatory impairment of the extremity from trauma or proximity of the graft to the femoral vessels. The defect in the fascia lata has caused no complaints of weakness but there has been slight bulging of the lateral thigh muscles and an occasional small res of parastheria has been detected.

TABLE III—FOLLOW UP STUDIES

time in months	Hernias followed up	Recurrences	Percentage recurrence
		3	9
3 to 24	30	5	4.9
5 to 30	30	3	9
37 to 45	30	3	9
40 to 54	6	—	—
Total		4	3.6
Seen by physicians	65	8	
Letter contact	30		

Table III gives analysis of the cases which have been followed up. The greater percentage of recurrences occurred in the first 3 years (78 per cent of the total).

SUMMARY AND CONCLUSION

A statistical survey is presented of 130 repaired upon recurrent hernias. One hundred and one cases were followed up for a maximal period of 54 months of which 76 per cent were re-examined by physicians. So far there have been 14 recurrences, or 13.6 per cent of the total followed up.

The causes for failure in the original repairs have been discussed from the standpoint of the sacs and the defects in the walls, respectively. The most striking finding in regard to the sacs was the marked preponderance of the direct type in 54.7 per cent, bilocular in 20.7 per cent and diverticular in 3.8 per cent of the recurrent hernias. The importance of the integrity of the fascia transversalis has been emphasized.

A modification of the original Wangensteen technique has been described and illustrated—a pedicle graft of iliofemoral tract fascia is transposed through the femoral canal. We feel that this type of radical hernioplasty replaces with a strong viable sheet like structure the all important fascial floor more deeply than does any other type of operation. Six patients operated upon with exclusive adherence to this modification were followed for over 30 months and there have been no recurrences. Seven patients operated upon in the past year have so far shown every evidence of successful results.

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PROTRUDED INTERVERTEBRAL DISCS

THE results of the surgical removal of protruded intervertebral disc during the past few years have established the syndrome on a sound anatomical, clinical and pathological basis. Repeated demonstrations in hundreds of instances have shown that protrusion of one or more intervertebral discs into the spinal canal is a common cause of intractable backache and sciatic pain. The demonstration of this syndrome is a memorable advance in the elucidation of the problem of chronic backache.

Backache annually results in untold pain and suffering and in a tremendous loss of man power. It is a complaint that is at times extremely difficult to explain and often results in knotty medicolegal battles.

Until the condition of protruded intervertebral disc was sufficiently understood to permit satisfactory clinical recognition and radiological demonstration, many patients erroneously were considered as neurotics or

pure malingerers. The recognition and correction of the pathological lesion have resulted in a large percentage of cases, in restoration of health to the individual and in a return to his former gainful occupation.

Our present knowledge concerning protruded intervertebral discs has been built up from the contributions of many contemporary writers. The earlier writers although unacquainted with the lesion as it is known today laid the foundation for many of the principles which are now employed in the diagnosis and treatment of this relatively common intraspinal lesion. The writings of Elsberg, Goldthwaite, Cushing, Sicard and Forestier, Adson and Dandy contributed in large measure to the present understanding of obscure intraspinal space taking lesions. These authors along with others, devised the means of diagnosing lesions which do not give objective neurological evidence of their presence or their exact location. These men laid the foundation for the successful surgical attack on such lesions.

The demonstration by Goldthwaite emphasized the great importance of intervertebral disc in the production of backache, sciatica, and paraplegia. His valuable paper was an outstanding contribution but unfortunately had to be rediscovered after a great deal of the more recent work had been done. The introduction of pneumomyelography and later of fluoroscopic examination of the subarachnoid space by means of radioopaque oil (lipiodol) was really the tool which led to the recognition of the fact that protruded intervertebral disc is not a rarity but a relatively common occurrence. When the lesion had been seen radiologically and had

been demonstrated repeatedly at the operating table it was only a step to discover that it was possible, by careful analysis of large series of cases, to correlate the symptoms and findings and to establish certain criteria which constitute the "disc syndrome"

The syndrome has become so well established that in the vast majority of cases the true nature of the underlying lesion accounting for intractable backache or sciatica or both can be recognized after a carefully taken and considered history and examination. Roentgenological examination by means of contrast medium is for the most part only confirmatory evidence. The diagnosis of this lesion, which was formerly considered rare, has been made relatively simple in the majority of cases since the frequency with which it actually occurs has been recognized. The method of treatment generally accepted by those who have had most experience with it suggests that the operative removal of protruded discs is a highly technical procedure and should be undertaken only by those trained to perform operations on the spinal cord.

The surgery of protruded discs has advanced rapidly and in keeping with the great progress made in the diagnostic field. The earlier operations were extensive and time consuming and necessitated a long period of hospitalization and convalescence. As knowledge of the clinical behavior, site of predilection, and pathology of the protruded disc and of the associated lesions (such as thickening and fibrosis of the ligamentum flavum) has developed, the operative removal of the protrusion has been simplified considerably as far as the patient is concerned. The simplified procedure demands considerable experience on the part of the surgeon. Most intraspinal intervertebral protrusions of discs today can be removed without the interruption of a

single neural arch. Many can be removed without the sacrifice of any bone of the spinal column. This, of course, leaves the spinal column as nearly normal as possible, in fact, postoperative roentgenograms of a spinal column will fail to disclose any change not seen in the pre-operative roentgenograms. This is an important consideration, particularly in medicolegal and compensation cases.

The results of operative removal of protruded intervertebral discs as has already been stated are, in the majority of cases, highly successful. The removal of the protruded part of the disc results in relief of disabling pain, and restoration of the individual to his former occupation.

The selection of cases, the type of treatment the patient has had previously, the accuracy with which the lesion is removed at operation, the postoperative care, and the question of insurance and compensation are important factors in determining the final result.

J GRAFTON LOVE

DISTENTION ASSOCIATED WITH SPREADING PERITONITIS FOLLOWING PERFORATIONS OF ABDOMINAL VISCERA

THE majority of physicians believe that abdominal distention is a sign which invariably accompanies spreading peritonitis. Authors of textbooks on surgery have maintained and medical students have been taught that it must be present before this diagnosis can be made.

Approximately 85 per cent of the deaths from spreading peritonitis follow perforation of the appendix, duodenum, gall bladder, or diverticula of the colon. Pelvic inflammatory disease, contamination of the peritoneum during or following operation, perforated malignant and non-malignant lesions of the stom-

ach, perforation of gangrenous intestine a Meckel's diverticulum perforated typhoid and tuberculous ulcer of the small intestine traumatic rupture of viscera, perforation of the esophagus and uterus are responsible for the remaining 15 per cent

The mortality of acute and subacute perforations is dependent upon early hospitalization. Acute perforations are usually admitted early but they comprise only a small percentage of the total number. With the exception of perforation of the duodenum frank perforations in the alimentary tract are rare. The sudden escape of a portion of the contents of the duodenum and stomach into the greater peritoneal cavity immediately produces irritation of the visceral and parietal peritoneum and the large nerve plexuses, resulting in agonizing morphine resistant pain shock, and persistent rigidity. The diagnosis is invariably made and the patient consents to immediate hospitalization—he knows something catastrophic has occurred.

The majority of perforations are subacute and consequently develop slowly. Usually more than 24 hours elapse between the initial involvement of the mucosa with subsequent gangrene and perforation of the serosa. During this period changes which are protective in character occur in the tissues in close proximity to the potential perforative site. These changes so limit the absorption of bacterial toxins that when perforation actually occurs the plexuses of nerves responsible for the institution of defensive measures are only moderately stimulated. Pain may be only slightly or moderately increased with no evident change in the physical signs. The one exception is a subacute perforation converted into an acute one by peristalsis induced by a laxative or some other drug.

Distention of the abdomen associated with spreading peritonitis may be extraluminal or

intraluminal local or general and may be due to gas or fluid or both. Extraluminal gaseous distention of the abdomen is uncommon but occurs locally in acute perforations of duodenal ulcers. Early evidence of this may be shown by a roentgenogram. Later the presence of gas can be demonstrated by percussion and measured as it increases. If the patient is seen within 2 hours after the onset of pain, and the lower border of liver dullness is marked on the epidermis, re-examination each succeeding 2 hours will show a step-ladder diminution. During this time peristaltic sounds will be absent and the lower half of the abdomen will show no evidence of distention.

Neither general nor local gaseous distention is an early sign of acute perforation of an acutely inflamed appendix. A gradual distention of the cecum and terminal ileum is evidence of the localization of a spreading process. General distention is usually indicative of a spread of the process.

Acute perforation of the gall bladder resulting in early spreading peritonitis is rare. Subacute perforations are comparatively frequent, but the process is so completely quarantined that symptoms and signs are few. Distention of stomach and transverse colon may occur; general distention is unusual.

Perforation of a diverticulum of the sigmoid is seldom sufficiently acute to cause a fatal spreading peritonitis. If a laxative has not been administered subacute perforations are preceded by the development of immunity in contiguous tissue; small abscesses are frequently absorbed; adhesions or fistula to the pelvic viscera often occur in the female; fistula to the bladder in the male. During the localization of these processes, physical examination or a roentgenogram frequently reveals a gradual increase in the diameter of the lower colon, at times of the adjacent ileum.

Of the remaining perforations which produce spreading peritonitis, rupture of the gangrenous intestine following acute obstruction is the most frequent. Perforation of the devitalized intestine usually occurs several days after the development of the obstruction. If the patient has been under observation and the distention from the obstruction has been controlled by the suction catheter, secondary distention may follow perforation but invariably the patient's reactive capacity is so low that this sign may be very slight or entirely absent. The exception to this is the sudden rupture of gangrenous intestine due to a subcutaneous or intramuscular injection of eserine or pituitrin.

Acute perforations of typhoid or tuberculous ulcers may be followed by early general distention, such perforations, however, are more often subacute and as they frequently occur in hospitalized patients a surgical opinion regarding management is sought comparatively early. A small percentage of these patients show air in the peritoneal cavity, as do acute blow outs in the intestine.

Patients die of spreading peritonitis because absorbed toxins have not been adequately neutralized. In the acute perforations, and to a lesser degree in the subacute, Nature's initial protective measure is the induction of intra-abdominal quietude, peristalsis ceases, the abdominal muscles contract, and the excursions of the diaphragm are limited. These measures, however, are only adjuvants to the processes which actually protect—proc-

esses which result in the development of local and general immunity.

Immediately following acute perforation absorption of the peritoneal contaminant begins. This is accompanied by the transudation of serum and the migration of neutrophils. Later the larger macrophages, mononuclears, and clasmotocytes appear and the serous coat may be covered with fibrinous exudate. In the subacute perforation, hyperemia, edema, and peritoneal transudate may precede actual perforation. Recent investigations have shown that in a definite percentage of cases this fluid contains antibodies¹. With the exception of frank duodenal perforation the preceding describes what occurs in the average case. The process is usually limited to a quadrant of the abdomen. Distention is not a significant sign. Coils of moderately distended intestine may be observed but juxtaposed will be loops of normal or contracted intestine, the tone and color of which indicate that a stage of compensation exists.

Early gross evidences of decompensation are the replacement of the normal pink color of the intestine by a dusky hue, loss of tone, and increase in distention—all are the result of toxins acting on the myenteric plexus.

General gaseous distention is equally as much a late sign of spreading peritonitis as a running pulse and cold, clammy skin—all indicate the failure of neutralization of toxins.

JOHN O BOWER

¹Titration of the exudate from the peritoneal cavity of patients operated upon for acute non perforative appendicitis shows antitoxin to the *Clostridium welchii* in 33.33 per cent of cases.

EARLY AMERICAN MEDICAL SCHOOLS

THE SPECIAL SCHOOL OF MEDICINE OF THE LOUISIANA STATE SEMINARY OF LEARNING

WILLIAM DOSTÉ POSTELL, M.S., B.S. in L.S., New Orleans, Louisiana

LOUISIANA State University owes its origin to certain land grants made to Louisiana by the United States Government in 1806 1811 and 1817 for use of a seminary of learning. The State Constitution of 1845 provided for the sale of these lands and for the establishment of the institution with the proceeds. In 1848 a Board of Visitors was appointed, whose duty it was to draw up a course of study arrange for the accommodation of students, and engage a superintendent and faculty. In 1853 after considerable discussion, a site in Rapides Parish some 3 miles from the present town of Alexandria was selected, and a suitable building was erected. William Tecumseh Sherman was appointed superintendent, 5 professors were engaged, and the instruction of 19 students was begun January 2, 1860.

A more unpropitious time could scarcely have been chosen. The first session lasted until July 1, 1860, and the second opened November 1. Before it had ended the War between the States broke out, Superintendent Sherman resigned to enter the Union Army and practically the entire faculty and student body departed immediately afterward to enter the Confederate Army. The Louisiana Seminary of Learning struggled along until 1863 when the Red River Valley was invaded by the Union Army but finally closed its doors April 23 of that year.

Literatus of the School of Medicine of Louisiana State University

Academic work was resumed October 2, 1865, with Major David French Boyd as acting superintendent. He had been appointed to that position earlier in the same year by James Madison Wells, Governor of Louisiana, just after the surrender of the Confederate forces in the Northern

part of the state. Major Boyd (like most of the first superintendents of Louisiana State University he soon became Colonel) had been a member of the original faculty and had resigned to enter the Confederate Army. He served as superintendent until 1880 and was reappointed for a two-year term in 1886.

In 1866 the Seminary building was destroyed by fire but activities were immediately transferred to Baton Rouge where the main plant has been located ever since. In 1870 the name of the Louisiana State Seminary of Learning was changed by Legislative Act to Louisiana State University. Later the University was merged with the Agricultural and Mechanical College which had been

opened in 1874 in New Orleans, and the two state institutions, united and constituted into one and the same institution of learning began their joint operation October 5, 1877.

Colonel David French Boyd who reopened the University after the War between the States and who guided it through the difficult days of reconstruction, early envisioned the Seminary as it was then called, as a great state university

where literature, science and all the arts may be taught, where the principles of truth and honor may be established,



David F. Boyd in the uniform of Confederate soldier. Reproduced from daguerrotype made during the War between the States.

and a noble sense of personal and patriotic and religious duty inculcated, in fine, to fit the citizen to perform justly, skilfully, and magnanimously all the offices, both private and public, of peace and war"¹

The right and duty of Louisiana State University to operate a school of medicine was specifically set forth in the Legislative Act of 1877 which is the charter of the present institution. This charter provides for¹

"general instruction and education in all the departments of literature, science, art and industrial and professional pursuits special instruction for the pursuits of agriculture, the mechanical arts, mining, military science and art, civil engineering, law, medicine, commerce and navigation"

But even before provision for a school of medicine had been made by legislative act, steps had been taken to provide medical training in the Louisiana State Seminary of Learning June 11, 1866, according to the minutes of the Board of Supervisors, a Mr. Boyce had introduced the following resolution²

"Whereas a general knowledge of Anatomy, Physiology and Hygiene is desirable in the students of this institution there be created a professorship of these branches, with a salary of one thousand dollars per annum with quarters and that the Surgeon of the Seminary shall be the professor of the said chair"

Previously, in February of that year, the vice-president of the Board had been authorized to advertise in the newspaper for a surgeon³

"who would also serve as professor of Chemistry, Geology and Mineralogy who shall be a graduate of medicine and an experienced physician, his testimonial embracing qualifications in both branches"

The necessary qualifications had been found in Dr. J. W. Wilson, a relative of the then governor of Louisiana, Henry W. Allen, and he had accordingly been elected acting surgeon of the seminary. Dr. Wilson, who was a native of Virginia, had practiced medicine for 15 years in St. Louis before entering the Confederate Army, but could not return to Missouri immediately after the War because of the test oath requirement of that state. The day after the resolution authorizing the establishment of the special school of medicine had been passed, he was notified of his appointment as surgeon and professor of anatomy, physiology and hygiene as follows²

"Louisiana State Seminary of Learning and Military Academy

June 12, 1866

"Dr. J. W. Wilson

"Surgeon, Louisiana State Seminary of Learning and Military Academy

"Sir I am instructed to inform you that the Board of Supervisors of the institution at its stated annual session yesterday chose you as the permanent Surgeon of the institution your compensation as such to be the medical fee of one dollar per month from each cadet in the institution, until the same shall be \$2000. You were also chosen professor of Anatomy, Physiology and Hygiene in the institution with a salary of one thousand (\$1000) dollars per annum—and quarters in the capacity of Surgeon and Professor with the understanding that until there shall be full employment for your time in your own especial department you will discharge such duties (the next word is illegible in the handwritten document) to the welfare and interest of the institution as you may be qualified for and may be assigned to by the Superintendent

"Hoping to hear from you soon that it will be agreeable to you to accept the positions to which you have been chosen with the salaries and conditions attached thereto, I am

"Very respectfully

"G. Mason Graham

"Vice-President of Board of Supervisors
Louisiana State Seminary of Learning
and Military Academy"

The Board also appointed Dr. John R. Page to the faculty of the special school of medicine to give the lectures in *materna medica*. Dr. Page, who, like Dr. Wilson, had served in the Army of the Confederacy, was a graduate of the University of Virginia.

The course of study, according to the catalogue issued in 1866,³

"embraces a preparatory and an academic department and two special schools, one of Civil Engineering and the other of Medicine and of the School of Medicine its purpose is to give a good preliminary preparation for the School of Medicine in New Orleans. *But more accomplished* In both the special schools, the French and Spanish languages, Belles Lettres, Mental and Moral Philosophy and Political Economy are taught, in the School of Medicine the study of Latin is pursued, and Anatomy and Physiology are studies in the School of Civil Engineering"

The School of Medicine in New Orleans was then the medical department of the University of Louisiana and is now the School of Medicine of Tulane University. The proposed instruction was to cover 4 years, the first 2 to consist of liberal arts courses and the last 2 to consist of specialized training in medicine. An insight into the educational ideas of the times is gained by certain provisions in the curriculum. Thus *materna medica*, mineralogy and geology were taught as a single course, and it will be observed

³Official Register of the Officers and Cadets of the Louisiana State Seminary of Learning and Military Academy Session Ending June 30 1866

¹ Acts Passed by the General Assembly of the State of Louisiana at the First Session of the Fifth Legislature Begun and Held in the City of New Orleans January 1 1877 and at the Extra Session Convened at the City of New Orleans March 2 1877. New Orleans George W. Dupre and Company 1877. Act No. 145.

² Minutes of the Board of Supervisors of the Louisiana State Seminary of Learning and Military Academy 1865-1876

SPECIAL SCHOOL OF MEDICINE

Junior Class—First Year

Studies	Professors	Texts
Anatomy Physiology	Prof J. W. Wilson, M.D.	Wharton, Anatomy and Carpenter, Physiology
Chemistry	Prof J. R. Page, M.D.	Boisson, Chemistry Lassalle, Agriculture Chemistry
French	Prof J. P. Butler Asst Prof R. A. Kern	Tylenchou, Histoire de France
Latin	Prof D. F. Boyd	Horace, Virgil

Curriculum for the Junior class in the Special School of Medicine, Louisiana State University of Learning and Military Academy, Alexandria, La., 1866

that Latin was a required course in the school of medicine, while anatomy and physiology were required in the school of civil engineering.

The catalogue further states:

The graduates in the special schools will receive diplomas with the title Graduate in the School of Civil Engineering and Proficient in the School of Medicine.

One of the interesting activities of the medical school was the early attempt to build up a medical library. According to Bulletin No. 20 of the United States Bureau of Education the embryo library contained 443 books of medicine and received the following scientific periodicals: *Edinburgh Magazine*, *Journal of Science and Art*, *Journal of Pharmacy*, *Popular Science Monthly*, *Annales de Chimie* and the *Scientific American*. Apparently all that remains of the original collection is a three-volume set of *Leçons orales de clinique chirurgicale* which is now in the Agremonie Memorial Library of the present school of medicine of Louisiana State University. The stamp on its title page, Louisiana State Seminary of Learning and Military Academy near Alexandria, La. is evidence of its inclusion in the earlier library.

Little seems to have been accomplished during the session 1866-1867 toward developing the special school of medicine and the authorities appar-

See footnote 2 on preceding page.
Edwin Whitfield, Library of Education in Louisiana, U. S. Bureau of Education, No. 20, Government Printing Office, 1896, Pp. 97-98.

SPECIAL SCHOOL OF MEDICINE

Senior Class—Second Year

Studies	Professors	Texts
Anatomy Physiology	Prof J. W. Wilson, M.D.	Wharton, Anatomy and Carpenter, Physiology
Maternal Medicine, Gynecology and Obstetrics	Prof J. R. Page, M.D.	G. S. Dwyer, Gynecology Dunn, Maternity Pritchard, Gynecology Practical instruction in anatomy, etc. and other surgical work and analyzing work
Spanish	Prof J. P. Butler Asst Prof R. A. Kern	Berthel, Spanish Teacher
Moral Philosophy	Prof D. F. Boyd	Whitely, Logic, Ethics, Moral Philosophy
Natural Lectures	Asst Prof J. M. Boyd	Bailey, Anatomy

Curriculum for the Senior class in the Special School of Medicine, Louisiana State University of Learning and Military Academy, Alexandria, La., 1866

ently realized almost 100 years ago that their efforts had been ill timed and premature. A resolution was introduced in October 1867 recommending that it be discontinued, but it was decided that action be deferred until the plan had been given a longer trial. The 1867 catalogue, however, makes no mention of the medical school, and the minutes of the board of supervisors show that Drs. Wilson and Page were assigned to teach other subjects.

So ended the first abortive courses in medicine taught at Louisiana State University. In spite of the specific provision in the Charter of 1877¹ for the establishment of a medical school, nothing was done in that direction until December 1930 when plans to open the present school in New Orleans were made. The first students were admitted in the Fall of 1931, the newly erected building on the grounds of the Charity Hospital of Louisiana at New Orleans was occupied in the spring of '33 and the first 4 year class was graduated in June, 1935. There is no doubt that Colonel David French Boyd, who is chiefly responsible for the University as it exists today would be more than pleased with the establishment at long last of the school which he had tried to establish almost 75 years earlier.

See footnote 2 on preceding page.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE treatise, *The Rectum and Colon*¹ by E. Parker Hayden, on the common complaints of the lower portions of the intestinal tract is designed primarily for the general practitioner. Based chiefly upon the writer's personal experience, it omits material of a controversial nature, which would be of academic interest mainly to the specialist. Because it describes treatment and surgical technique which have given excellent results in the author's hands, presented in a simple, understandable, and effective manner, the book is recommended as a dependable guide for those who are called upon to relieve these disorders. Especially practical is the chapter devoted to a consideration of symptoms, since a thorough knowledge of the pathological physiology allows a more successful application of the principles used in diagnosis and treatment.

The book is well written, nicely proportioned as to subjects and their respective importance and is clearly printed and illustrated with good plates and photographs, which are sufficiently helpful but not so profuse as to make the cost excessive. It will be of value to anyone wishing more complete information on proctological and colonic troubles, and physicians undertaking surgery of these parts should find it a definite aid.

DURAND SMITH

THE book, *Nitrous Oxide Oxygen Anesthesia*,² by F. W. Clement, represents a thorough compilation of material on this subject. It presents the teachings and findings of Dr. E. I. McKesson, who developed the technical administration of nitrous oxide oxygen to the point where it could be used on all types and conditions of patients, for every requirement and emergency of surgery and anesthesia, and every operative procedure in both the general surgical and dental fields. It also presents the author's own impressions and experiences resulting from the use of nitrous oxide oxygen over a period of many years.

The book is well written and easily read. It is printed on a fine grade of paper, is well bound and illustrated, and comprises 268 pages.

The chapters on the physiology of anesthesia are especially well presented. It charts a classification of signs and symptoms of nitrous oxide oxygen anesthesia and discusses the fallacy of cyanosis *per se* as a true sign of nitrous oxide oxygen anesthesia. The administration of nitrous oxide oxygen is discussed in detail with emphasis on the primary and second-

ary saturation techniques, depression tests, positive method of anesthesia, endotracheal anesthesia, the advantages and disadvantages, and comparison with other gaseous anesthetics used.

Some of the principles brought out are contrary to those practiced by many other anesthetists, especially the technique of secondary saturation which is considered by many to be fraught with the dangers of asphyxia.

As a guide and reference book for the physician anesthetist, this excellent work can be most highly recommended.

MARY KARP

AS the title implies, Professor Jamieson's *Illustrations of Regional Anatomy*,³ is a pedagogical offering in a series of pictures of gross human structure, there is no text accompanying and no directions designed to guide the dissector, even the legends are of the briefest order.

The illustrations are grouped in 7 short volumes. In each of the sections the pages are fitted on to loose leaf pillars from which they are readily removable for rearrangement in any sequence which meets the current need of the student. The pages are printed on one side only, so that they may be pasted into notebooks.

The 305 illustrations cover the subdivisions of the body: central nervous system, head and neck, abdomen, pelvis, thorax, upper limb, and lower limb. The head and neck are allotted the largest number of figures, the thorax the smallest number.

The brain is extensively illustrated in sections, basal nuclei, motor, and sensory areas are indicated diagrammatically, as are also the principal tracts, commissures, etc. Blood vessels, cerebral ventricles, and choroid plexuses are all presented with profuse coloring.

The head and neck are illustrated by drawings which include entire dissection fields, layered dissections of individual sense organs, diagrammatic representations of nerve plexuses, and transverse and sagittal sections. Some of the figures would be baffling to a beginner, since they do not indicate what has been excluded, or which layers have been reflected in order to bring into view the stratum which the figure portrays. Others lose value by being too courageously diagrammatic, suggesting but not closely resembling the structure as it appears in the human body.

The section on the abdomen contains ingeniously diagrammatic illustrations of the abdominal muscles.

¹THE RECTUM AND COLON. By F. Parker Hayden. A.B. M.D. 1 A.C.S. Philadelphia: Lea & Febiger, 1930.

²NITROUS OXIDE OXYGEN ANESTHESIA. McKesson, Clement. VIEW POINT AND TECHNIQUE. By F. W. Clement. M.D. Philadelphia: Lea & Febiger, 1930.

³ILLUSTRATIONS OF REGIONAL ANATOMY. By E. B. Jamieson. M.D. Sections I-VII. 4th ed. Baltimore: Williams & Wilkins Co., 1930. (American distributor.)

and the inguinal canal, but some of them sacrifice anatomical clarity for schematic vividness. The treatment of the inguinal region, mesenteries, blood vessels, kidneys, and suprarenals is highly conventional resembling models rather than dissections. The schematic drawings of abdominal layers are architectural achievements but take considerable liberty with the real fabric of man's body.

In the volume on the pelvis and perineum color is given lavishly and helpfully used but the author's order of plates is seemingly quite haphazard for a section of anatomy in which a knowledge of progressive stratification is of the greatest importance. While the layers of the pelvic and urogenital diaphragms are shown in schematic clearness, they are not portrayed accurately as fascial layers of the perineum are shown in disjunction, not as strata continuous with layers in adjacent regions, the relations of the pelvic viscera to their ligamentous, fascial, and diaphragmatic supports would be of little use in training critical students for the practice of gynecology, urology or proctology. The figures illustrating the anatomy of the female pelvis are the most unfortunate of the entire lot.

In the set of plates portraying the structure of the thorax the schematic method is utilized to greater advantage since much of the important anatomy of the thoracic cage and its viscera may be taught from transverse and sagittal sections and from surface projections of organs.

In the sections on the upper and lower limbs, the figures which show the areas of muscular attachment on the bones are fundamentally similar to those found in the standard textbooks, atlases, and manuals of gross anatomy. Here the order is the logical one of successive layers, from cutaneous nerves, superficial veins and fascial sheaves through progressively deeper layers of muscle. In the more simple figures, for example, those dealing with the synovial sheaths of the hand and foot the schematic plan is utilized to great advantage but when this same device is employed to show the tendons, nerves, vessels, and muscles, the collection of transected structures forms a bewildering assemblage.

The colors employed in the illustrations seem, in some instances, unnecessarily garish but the reader cannot blame either the author or illustrator for indulging in such innocent gaiety when chromatic feasts of this kind are so rare in the history of book making. Continued examination of the plates lowers one's opposition to the resplendent use of color since it is realized that the varied hues function as ocular signals, for what student would ever fail to remember the tripartite character of the innominate bone, after he has seen its units done in gray, cerise and cerulean blue?

Taken as a whole, *Illustrations of Regional Anatomy* is a useful adjunct to the student's regular anatomical library. It treats of the kind of anatomy which is customarily presented in charts. Its graphic character is analytical of the standard type illustration of take-apart models found universally in pres-

ent day laboratories. The volumes of figures will serve as a link between the standard atlas which the student uses at the dissection table and the blackboard drawings which are customarily featured in the lecture in gross anatomy. BARRY ABBOTT.

IN a treatise of 400 pages entitled *Sterility I Impaired Fertility* Lane Roberts presents the subject in comprehensive manner. The work covers this important problem of the obstetrical and gynecological field in a detailed fashion. Each phase of it is given thorough consideration. The male factor is given a place equal to that of the female, and it is encouraging to find that this phase of sterility is being stressed as it should be. Anomalies in the male genital tract, difficulties resulting from physiological disturbances, methods of collecting and examining semen, and evaluation of the results obtained are clearly set forth.

In considering the female role in sterility the human cycle is reviewed. Illustrations of the endometrium at different stages of the cycle are included. The endocrines and disturbances of the endocrine mechanism are discussed in relation to the human cycle.

Under the investigation of specific functions ovulation and methods for the determination of its occurrence, the patency of the tubes, endometrial changes, and tests for determining the state of the endocrines are discussed. The rôle of hormones in the production of sterility and their uses in its treatment are all presented.

This volume is recommended to anyone who is interested in the subject of sterility.

CAROLINA C. DORRICK

THE title of the excellent 65 page monograph, *Unward Effects of Nitrous Oxide Anesthesia* is somewhat misleading. It deals, in fact, with the untoward effects of anoxia which may accompany nitrous oxide anesthesia. It calls attention to the morbidity and mortality following nitrous oxide which have only recently been understood although they have long been observed.

The author Cyril B. Courville, has conducted competent and painstaking investigation into the neuropathology found in victims of nitrous oxide administration, based on 36 cases which have come under his observation. Case histories and post mortem findings are presented.

The pharmacology and toxicology of nitrous oxide are discussed. The important fact is noted that deep surgical anesthesia with nitrous oxide is obtained only with apnoea. A complete review of the neuro-

STERILITY AND IMPAIRED FERTILITY. F. THOMSON, DIAGNOSES AND TREATMENT. By Eugene Lane Roberts, M.S., B.A., M.D., CO. About 400 pages. M.D. M.B.C. University of Chicago Press and B.P. 1930. D.R. P.P. 1930. K. 1930. Foreword by The Rt. Hon. Lord Horder O.C.V.O. M.D. F.R.C.P. New York. Paul Hoeber Inc. 1930.

UNWARD EFFECTS OF NITROUS OXIDE ANESTHESIA, WITH PATHOLOGICAL EVIDENCE TO REGIONAL ANOXEMIA AND PATHOLOGIC INFLUENCES. By Cyril B. Courville, M.D. 65 pages. Foreword by Dr. Leonard Henderson. Mountain View Calif. Pacific Press Publishing Ass. 1930.

pathological findings in asphyxia from various causes is presented together with certain general pathological considerations

The work is amply illustrated. It is recommended for careful study by all those whose patients receive anesthetics, and it should be "required reading" for anesthesiologists.

The foreword by Dr. Yandell Henderson is a fitting introduction to the text. FRANK J. MURPHY

THE increasing interest in industrial medicine and surgery justifies the publishing of Schwartz and Tulipan's very important book, *A Text-Book of Occupational Diseases of the Skin*,¹ for it supplies the physician's need for detailed and systematized knowledge of this subject.

Statistics show the growing importance of occupational dermatoses. In England, in 1936, there were 1,771 cases of occupational dermatitis, 84 cases of chrome ulceration, and 142 cases of occupational epitheliomas. All other occupational diseases that were compensated totaled 428 cases. It is stated by English writers that these figures do not represent the actual incidence of occupational dermatitis because only those workers who are incapacitated for 1 week or more and those who receive compensation are reported. Prosser White estimated that at least 18,000 to 19,000 cases occurred in England each year.

In 1933, 9 of our states, which kept records, reported 5,787 cases of compensated occupational dermatoses among a total of 8,875 occupational diseases, or about 65 per cent of all diseases. The latest available records from 5 of these states show that while the number of all occupational diseases has decreased in recent years, the proportion of dermatoses has increased from 65 per cent for the years 1932, 1933, and 1934 to 69 per cent in the years 1936 and 1938.

A study of the compensation records of the several states shows that the average loss of time per year for compensated cases of occupational dermatoses is about 10 weeks, and the average compensation paid is about 100 dollars. In addition there is an average cost of medical care of about 90 dollars. It is, therefore, estimated that the annual loss from occupational dermatoses in the United States is approximately 4,000,000 dollars. Most of the material in this book is based upon the authors' own observations and experiences and the remainder upon reports and observations of other workers in the field.

A very important feature of the work is a description of the various industrial processes, such as the tanning of leather, the manufacture of rubber,

electroplating, the making of soap, and the manufacture of explosives. Every important industrial process is discussed briefly but so adequately that the reader is given a fuller understanding of the background on which dermatoses develop. There are interesting chapters on cosmetics, dyes, mycotic infections, occupational cancer, and diseases of the mouth. The final chapter contains a list and a detailed description of the chemicals which are known to be or which can be skin irritants.

The book contains a vast fund of information and is well written. The text is printed in large type on good paper. The illustrations are numerous and excellent, and there is an extensive bibliography at the end of each chapter. This reviewer unhesitatingly recommends it to every dermatologist, industrial physician, and general practitioner. The authors are to be congratulated on producing a book that should be a welcome addition to any medical library. EDWARD A. OLIVER

THE 838 page English translation of Bing's fifth edition of his *Lehrbuch der Nervenkrankheiten*² contains 30 chapters and has 207 illustrations. The translator has rearranged and augmented the original for adaptation to American usage. Despite this the very cogent observations and conclusions of Professor Bing are retained.

The author's style of presentation is entirely in accord with that of the reviewer. If in neurology one must be methodical and accurate, it follows that the discussion of entities should be along the lines of an easy understanding, as far as possible, instead of forcing the student to memorize signs and symptoms. Professor Bing has written this book with the former in mind. All of the chapters are up to date and are written for the student, however, it is an excellent reference book for the neurologist as well. Following each section there is a very large bibliography of both American and foreign contributors. A considerable amount of discussion regarding treatment together with written prescriptions is to be found in this book. There are chapters on peripheral nerves, dyskinesias, muscular atrophies, degenerative diseases, demyelinating disorders, syphilis of the central nervous system, arteriosclerosis and hemorrhages, infectious diseases and intoxications, aphasia, apraxia and agnosia, tumors, diseases of the cerebellum, disease of the endocrine glands, diseases of the autonomic system, convulsive disorders, headaches, and psychoneuroses. The illustrations are very good. This textbook is a desirable one and is recommended to all students and neurologists. T. T. STONE

¹A TEXT BOOK OF OCCUPATIONAL DISEASES OF THE SKIN. By Louis Schwartz M.D. and Louis Tulipan M.D. Philadelphia: Lea & Febiger 1939.

²TEXTBOOK OF NERVOUS DISEASES. By Robert Bing. Translated and enlarged by Webb Haymaker. From the 5th German ed. St. Louis: The C. V. Mosby Co. 1939.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

FINISH YOUR EXPERIMENTAL CLINICAL EXPERIMENTAL SCHOOL YOUR EXPERIMENTATION CLINICAL. By J. Pon Orfila and A. Pon De Santiago. Montevideo: Casa I. Barreiro Y Ramos, 1939.

MANUAL DE FISIOPATOLOGIA QUIMICA CIRCUIT EXPERIMENTAL. By J. Pon Orfila and A. Pon De Santiago. Montevideo: Tipografia Atlántida, 1938.

THE FOREIGN VITAL: INTERNAL MEDICINE. By Wallace Mason. 1st ed. A.B. M.D. M.S. (in Med.) F.A.C.P. First edition revised. New York, London: D. Appleton-Century Co., 1940.

OBSTETRICS AND GYNECOLOGY. By The Departmental Staff of the University of Chicago and Other Contributors. Edited by Fred L. Wade, M.D. F.A.C.S. 10th ed. and 2. Philadelphia: Lea & Febiger, 1940.

ITALY AND NERVOUS DISEASE: SURVEY OF THE INCIDENCE ETIOLOGY AND TOXIC EFFECTS OF THE CONDITIONS PRODUCING DEATH OF THE FETUS IN UTERO AND THE INFANT IN THE EARLY DAYS OF LIFE. By Edith L. Potter, M.D. Ph.D. and Fred L. Wade, M.D. Chicago: The University of Chicago Press, 1940.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. 64 for the Year 1939. Edited by Richard W. T. Lunde, M.D. St. Louis: The C. V. Mosby Co., 1940.

SHOCK AND RELATIONSHIP CAPILLARY PERMEABILITY. By Virgil H. Moom, A.B. M.Sc. M.D. London, New York, Toronto: Oxford University Press, 1938.

CANCER IN CHILDHOOD, AND DEVELOPMENT OF CERTAIN BENIGN TUMORS. Edited by Harold W. Dargatzis, M.D. F.A.P. St. Louis: The C. V. Mosby Co., 1940.

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OXFORD MEDICAL PUBLICATIONS. THE SEXUAL PLEASURE BOOKS AND ANATOMY. By Clifford Allen, M.D. M.R.C.P. D.P.M. London: Oxford University Press, 1940.

MACLEOD'S MEDICAL LECTURES, 1939. TEXT MACLEOD'S OUTLOOK IN SURGERY. By G. Grey Turner, D.Ch. (Durh. Hon.) M.S. F.R.C.S., F.A.C.S. (Hon.) F.R.A.C.S. (Hon.) Glasgow: Jackson, Son & Co., 1939.

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TREATMENT WAR WOUNDS AND FRACTURES: THE SPECIAL REFERENCE TO THE CLOSED METHOD AS USED IN THE WAR 1914-18. By J. Trautman, M.D. With Foreword by H. W. Bennett, M.D. F.A.C.S. New York: Paul B. Hoeber Inc., 1940.

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ATL ZENANIA

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CHARLES BELL (1774-1842) Discoverer of the distinction between motor and sensory nerves, united the artist and poet with the philosopher and surgeon, an imaginative, ardent teacher with a single-minded devotion to his work, assumed direction of Hunter brothers' medical school in Windmill Street in 1812

"Even yet I am not rich enough to boast of my poverty"

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

FROM TOPOCAL EXPERIMENTAL CLINICA, EXPOSICION INTERNACIONAL VITAL EXPERIMENTACION CLINICA. By J. Pos Orfila and A. Pos De Santiago. Montevideo: Casa A. Barreiro y Ramon, 1930.

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SURGERY

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THE EFFECT OF ZINC PEROXIDE TREATMENT ON ULCERS DUE TO THE MICRO-AEROPHILIC HEMOLYTIC STREPTOCOCCUS

THOMAS A. SHALLOW, M.D., F.A.C.S., KENNETH E. FRY, M.D., F.A.C.S., and
EDWIN J. PULASKI, M.D., Philadelphia, Pennsylvania

IN 1935, Meleney (3) established as a clinical entity the chronic, undermining, burrowing ulcers due to the micro-aerophilic hemolytic streptococcus, and demonstrated their favorable response to potent zinc peroxide therapy. The modes of origin (4) of the disease process include the following: First, in incised, infected lymph glands, second, in operative wounds, mostly associated with the intestinal or genital tracts, third, secondary contamination of some pre-existing infection.

The outstanding features of the disease, he pointed out (5), are as follows: (1) That the ulcer may attack any part of the body's surface and any person regardless of age or sex, (2) the micro-aerophilic hemolytic streptococcus is the etiologic agent, (3) the lesion is characterized by prolonged suppuration with the development of an ulcer having undermined skin edges, and sinuses burrowing into the deeper tissues which tend gradually to enlarge the ulcer. The base is usually composed of grayish, shaggy, gelatinous granulations. Daughter ulcers are often produced, either by surface inoculation or by burrowing from be-

neath, and these may fuse with the main ulcer. Muscle and bone are not often affected. (4) Fever and pain with considerable prostration may be present in some cases but entirely absent in others. (5) Treatment with the ordinary antiseptics is usually without permanent effect. The ulcer goes on as an ordinary infection for a time and may show considerable improvement with the treatment used. Ultimately, however, such improvement ceases and the infectious process comes to a complete standstill, or gets worse again, never healing over completely. (6) Properly applied zinc peroxide cream controls the spread of the infection. There are three criteria for success in the use of zinc peroxide: (1) The chemical agent must be potent. Du Pont's "Z P O" is satisfactory. (2) The freshly prepared creamy suspension in water must be in intimate contact with all parts of the infected surface. If exposure cannot be obtained by direct application, surgical excision is necessary. (3) The dressing must be effectively protected against evaporation and drying.

Furthermore, as Meleney himself states, little has been recorded in the literature to focus attention on the early diagnosis of these ulcers, so necessary for the institution of proper

From the Surgical A Service of the Jefferson Medical College Hospital, Philadelphia, Pennsylvania.



Charles Bell

1774-1842

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From the Surgical A Service of the Jefferson Medical College Hospital Philadelphia, Pennsylvania

treatment. It is only through the publication of case reports (1 2 7 8 9) from time to time that the attention of physicians will be directed to this disease when unusual ulcers are encountered.

It is the purpose of the authors of this paper first, to report 6 cases showing the typical clinical characteristics of chronic, undermining ulcers due to the micro-aerophilic hemolytic streptococcus, observed and treated on the Surgical A Service of the Jefferson Hospital second, to stress the importance of early diagnosis third to urge that anaerobic as well as aerobic cultures be requested routinely on all cases with frank suppuration which fail to respond to ordinary measures fourth, to record and re-affirm the favorable influence of zinc peroxide on the course of the infection.

The clinical case reports follow

CASE Reg. N. ZH 575 E. B. aged 46 years white female, admitted to the hospital December 14, 1936, discharged February 4, 1937 Result death.

On May 1, 1936 patient was given prophylactic typhoid vaccine (T. A. B.) inoculation into the left deltoid muscle. A immediate local reaction followed with abscess formation, which was opened and drained. There is no record of culture having been taken at that time. Frank suppuration as rather low nevertheless on June 7, he was told by her physician that the lesion had subsided sufficient for her to undertake contemplated voyage. E. g. land. She had considerable pain with prostration while en route, the abscess spreading, and he stated that these were the onset of berilliosis. During the trip the incisions were made into the infected area. She landed at Plymouth on June 6 with cellulitis of the left shoulder and upper arm, and as admitted once to the Prince of Wales Hospital. At this time the wound involved the entire left shoulder down to but not including the joint. There were pockets of pus in the peripheral portion of the wound. The skin distal to the abscess as erythematous darkened and looked as if it would slough. There was no regional lymphadenopathy. The pockets were laid open with free drainage and C. metal tubes were inserted. Continuous Daks treatment was adopted. The blood Wassermann as negative. The temperature for the first 36 weeks varied from 100 degrees, till July when it commenced to rise, settling down in the next week to around 99 degrees again. The pulse as not duly elevated. Toward the end of July and during most of August and early in September there was tendency to increasing rise of temperature which slowly and gradually was maintained with increased pulse rate during September and October. Early in August pure culture of *Streptococcus* *reus* as

found and certain number of vaccines were given, but these proved ineffective. No anaerobic cultures appear to have been made. Scarlet fever, diphtheria as given in June likewise media and protozoal tablets, all without benefit.

Three or four operations were performed to open and drain the pockets which had formed from time to time but in spite of all form of therapy the infection spread under the deep fascia, with resulting necrosis. Baths and intralesional zinc peroxide were tried but appeared to irritate rather than to do any good.

Early in November another investigation of the pus was made with the result that hemolytic streptococcus was cultivated, with some colonies of staphylococcus, diphtheroids, and *Bacillus proteus*. No tubercle bacilli were seen on smears. No anaerobic cultures were done.

X-ray examination of the left arm and shoulder showed nothing abnormal present in the bones.

On December 9, 1936, the patient sailed for America and on December 14 was taken at once from New York to Jefferson Hospital. She was emaciated, shallow quite prostrated, and all pain.

Physical examination. Over the left axilla, arm, and shoulder especially posteriorly the skin and subcutaneous tissues were destroyed and the muscles were lying clearly exposed, with the skin edges undermined and the entire surface of muscles coated with thick yellow purulent discharge. The flaps were undermined and there was great deal of induration. The elbow was quite stiff. Below the forearm as edematous. There was some puffiness with discoloration up the neck posteriorly (Fig. 1).

Carrel tubes were placed the underlying skin edges of the wound as dressed with acid-fast solution. Cultures from the arm on December 18, 1936 yielded *Streptococcus hemolyticus*, micro-aerophilic, *Staphylococcus reus*, *Staphylococcus albus*, and diphtheroid bacilli. No strict anaerobes were recovered. Ten days later culture of the ulcer revealed *Bacillus proteus*, *Bacillus pyocyaneus*, *Staphylococcus reus*, and *Streptococcus hemolyticus*. The blood culture as negative.

The wound failed to respond and on December 31, the undermined flaps were excised until normal tissue as reached then the entire ulcerated lesion as covered with zinc peroxide cream then the gauze soaked zinc peroxide, and finally the thick vaselined gauze and dressings. Dressings were changed daily or every other day. The lesion looked much better though the drainage continued no less copious. However, the week there as drop in temperature and pulse. The patient as less toxic and general condition as noted much improved. The copious discharge continued. At this time the patient developed pressure sore at the base of the spine. By January 3 the fever had again risen and some edges of the original ulcer showed evidence of beginning spread of undermining. Culture at this time again yielded *Streptococcus hemolyticus* which as proved to be micro-aerophilic and *Staphylococcus reus*. The infection now also yielded the

base of the spine with considerable spread and much foul drainage. From this time on, both lesions progressed unchecked. The temperature dropped to subnormal, the pulse continuing around 120. The patient grew gradually weaker and more toxic and died on February 14. Permission for postmortem examination was denied.

CASE 2 Reg No AH-4119 A P, aged 41 years, colored female, was admitted to hospital October 12, 1937, discharged November 24, 1937. Result improved.

This patient, a very obese colored schoolteacher, came to the hospital complaining of painful ulceration on the outer surface of the right leg just above the ankle, exact duration not known, but probably 3 months. Weight bearing increased the pain. The ulcer had persisted in spite of varied self-medication, and had grown larger, especially during the 2½ weeks prior to admission. She had received no medical treatment.

Physical examination revealed an irregularly shaped ulcer just above the external malleolus of the right leg, with flat edges and discharging sinuses. A thin discharge exuded from a gray surface. The clinical impression was tertiary luetic ulcer.

Cultures on admission October 3, 1937, yielded a hemolytic streptococcus, aerobic, in conjunction with *Staphylococcus albus*. No anaerobic culture was made. Zinc peroxide treatment was instituted at once. In the interim the blood Wassermann and Kahn were reported as four plus. In addition to the zinc peroxide, she was then placed on mixed antiluetic treatment. The culture on October 14 still showed hemolytic streptococcus and *Staphylococcus albus* present on aerobic plates. On October 20, 1937, anaerobic culture gave no growth in 48 hours. The wound infection had apparently cleared before the causative organism had been isolated and properly identified. The ulcer healed over quite readily and in 4 weeks had almost closed over completely. The zinc peroxide treatment was discontinued, and warm compresses were applied. No cultures were taken. In another week there was complete closure of the wound by epithelium. Patient was discharged, cured, in care of the physician referring her and he was advised that she had syphilis.

CASE 3 Reg No AH 5833 W L, aged 56 years, white male, was admitted to the hospital December 8, 1937, discharged December 23, 1937. Result improved.

In February, 1936, the patient sustained trauma to the left forearm just below the elbow. Swelling and ecchymosis followed and receded gradually without treatment. In February, 1937, he noticed over the same area a "boil" which increased in size and later ruptured, draining pus. His doctor used various applications and there was considerable healing of the ulceration with crust formation. The patient then fell and knocked the crust off, and thereafter the ulcer spread with attendant frank suppuration. Subsequently other areas broke out



Fig 1 Case 1 Seven months after onset of the disease. Note the undermined skin edges, burrowing sinuses into deeper tissues, daughter ulcers, and bridges of skin. The base is composed of grayish, shaggy, gelatinous granulations.

on the forearm, first as abscesses and later as open sinuses. He states that the lesions became intermittently better and worse until 5 weeks prior to admission, when the one on the anterior surface of the forearm began to spread, draining more than before. He gave a history of chancre at the age of 18 years for which he had received some treatment, details not known. Cultures taken in the referring physician's office on December 1, 1937, were reported by the Jefferson Hospital laboratory as "*Streptococcus hemolyticus*, micro aerophilic, *Bacillus pyocyaneus*. No yeasts or molds recovered." Patient sent to hospital because of failure to check spread of the lesion.

On admission the left forearm disclosed an area of small burrowing sinuses, extending from the elbow to the middle third of the arm, mainly on the extensor surface, with the exception of one large, punched-out ulcer on the dorsolateral surface. The ulcers had smooth, round, curled edges, presenting a punched-out appearance, with granulating bases. The edges were undermined for some distance back, and some of the ulcers were connected by sinuses. In view of the history of syphilis and four plus Wassermann and Kahn, the diagnosis was tertiary luetic ulcer with the undermining due to secondary infection.

Culture taken on December 9, 1937, yielded no strict anaerobes. The aerobic plates showed *Streptococcus hemolyticus* and diphtheroid bacillus, unclassified.

The wound was dressed daily with a freshly prepared zinc peroxide cream and sealed off with thick vaselized gauze. Within a week the ulcers became less inflamed with considerably less suppuration. The



Fig. 2. Case 4. T and one-half years after onset, showing ulceration of the right arm, involving the entire skin thickness with undermining of the skin edges.

examinations took on a pinkish healthy appearance. The undermined area filled in and epithelialization was in evidence. Cultures on December 17, 1937 yielded *Bacillus pyocyaneus*, and no anaerobic organisms. By December 23, the healing had progressed so satisfactorily that the patient was discharged in care of the referring physician for continuance of treatment with zinc peroxide and for antibiotic therapy.

Correspondence with the family physician reveals that the ulcer had become completely epithelialized within 3 weeks after discharge from the hospital. The patient is seen weekly for antibiotic treatment by his physician, and there has been no recurrence.

CASE 4. Reg. No. ZH 547 H. C. aged 50 years, white female, as admitted to hospital June 5, 1936, discharged June 20, 1936. Result improved.

Two years prior to admission patient developed an infected hair follicle on the extensor surface of the right arm just below the elbow. The infection progressed until the bacteria attained the size of a lemon, when it was incised and drained. Instead of healing, an ulcer developed and spread until it almost completely encircled the arm, denuding an area 6 to 8 inches wide. Progress from then on varied. At times there was considerable healing, only to be followed by further breakdown. Blood Wassermann taken after a year of various treatments as alleged to have been positive. However, when repeated the report was consistently negative. Nevertheless, two very sketchy courses of antibiotic therapy were given, with little change in the character of the ulcer. Roentgen therapy was also tried and had no favorable effect. She was then sent to the hospital, the diagnosis being tertiary lues suspect. No cultures were made.

Physical examination revealed an ulcerated area on the right arm which almost completely encircled it. It involved the entire skin thickness and was sharply demarcated from the surrounding tissues. The edges were undermined. The raw surfaces were from gray to bright red in color granular in appearance, and covered with a thin layer of pus. There was no gangrene. A consulting dermatologist made diagnosis of gumma, and advised local applications of mapharven, in conjunction with regular anti-



Fig. 3. Case 4. Ulceration entirely healed. It has no undue contracture or fixation of the joint. Through some misunderstanding, less identical with the preceding figure are not obtained.

therapy. The blood Wassermann was negative. The patient was discharged improved in care of the out-patient department.

She was readmitted November 16, 1936 (Reg. No. ZH 4937) after a course of bismarven and iodide therapy without cure. Repeated serological tests were negative. Lymphopathia venereum as best considered, the Frei test being negative in 24 hours and questionably positive in 48 hours.

Biopsy of the ulcer margin was performed and the diagnosis of Chronic inflammatory ulcer of the skin, granulomatous type of lesion made. Various local measures were tried subsequent to this, and antibiotic therapy as continued. Culture on November 7, 1936 yielded *Streptococcus hemolyticus* and a diphtheroid bacillus erobically. No anaerobic cultures were taken. She was treated as an out-patient from this time until October, 1938.

The ulcer in the meantime had become considerably smaller, only a small area of un-united tissue remaining. This resisted all forms of treatment. In August, 1938, the wound was scratched by the claws of a dog. The ulcer then spread again with copious drainage. Smears were taken from the wound edges and aerobic cultures yielded only *Staphylococcus albus*. She was readmitted on October

(Reg. No. B11420) for excision of the infected area (Fig. 2). At this time a request was made for an anaerobic culture of swabs from the ulcer edge, and growth of hemolytic streptococcus micro-aerophilic was obtained. The patient was then treated with zinc peroxide. There was prompt favorable response with diminution in the size of the lesion. She was discharged November 2, 1938 in care of the family physician with note about the method of treatment, and advice to return to the hospital for plastic surgery if complete epithelialization of the wound was followed by limited elbow motion.

Patient was seen February 13, 1939, and there was no recurrence. The wound was completely healed and with no undue contracture nor fixation of the joint (Fig 3).

CASE 5 Reg No AH-0868 J P, aged 17 years, white male, was admitted to hospital April 27, 1938.

Six weeks prior to admission the patient noticed difficulty in flexing the left knee. A swelling appeared in the popliteal space, and there was some redness and swelling of the posterior aspect of the thigh. On the advice of his physician he applied hot magnesium sulphate compresses. The swelling progressed with increasing pain and fixation of the joint. After 3 weeks the abscess opened and discharged a copious quantity of bloody yellow pus with instantaneous relief. Daily ichthyol ointment dressings were applied for 2 weeks. Instead of healing, the wound continued to discharge and the patient was hospitalized.

Physical examination on admission revealed over the left gastrocnemius muscle an irregular wound discharging thick pus and some blood. The leg was painful on motion. There was a dark, red discoloration of the skin and increased local temperature in the popliteal space. This area was fluctuant and extremely tender. Above it, on the posterior aspect of the thigh, the skin was discolored and indurated. The left inguinal nodes were tender but not unduly enlarged.

Aerobic culture was taken and the *Streptococcus hemolyticus* and the *Staphylococcus aureus* were identified. Swabs taken from the margin of the wound 2 days later gave *Streptococcus hemolyticus* in pure culture. No anaerobic culture was made. Roentgenogram of the bones of the leg was negative.

On April 30, 1938, incision with drainage of the popliteal space abscess was done. Culture was repeated on April 30, 1938, and showed the *Streptococcus hemolyticus* and the *Staphylococcus albus* on aerobic and anaerobic plates. A week later the infected sinus was further exposed and drained. Zinc peroxide therapy was then tried. No attempt was made carefully to seal off the cream once applied. The potency of the zinc peroxide was not determined. Complete exposure of the infected area was not effected. The result was unsatisfactory and this form of treatment was abandoned and replaced by hot boric acid compresses. Sulfanilimide was given orally. The temperature for the first 2 weeks fluctuated between 98 and 100 degrees but thereafter was seldom higher than 99.2 degrees. The patient was discharged June 3, 1938, in care of the surgical out patient department, improved, and advised to return daily for re dressing. At the time of discharge the ulcer was about 9 inches long, and filling in.

However, his next visit was not until June 13, by which time the ulcer had increased in size, with considerable suppuration, and he was readmitted to the hospital, June 15, 1938 (Reg No BH-497). Continuous hot boric acid compresses were re-instituted. On culture only a *Friedlander bacillus* was recovered, and no strict anaerobes. No recheck was made. In

the course of a month suppuration ceased, the granulations had filled in most of the ulcerated area to the level of the adjacent skin, and there was epithelization inward from the margins. By July 17, the wound was about half epithelized and patient again discharged in care of the surgical out patient department.

He returned once a week for redressings. Granulation tissue became exuberant and its growth was checked with silver nitrate. He received a course of ultra-violet irradiation with no resultant benefit. Gentian violet, then allantoin, then urea ointment were used but the ulcer did not respond. When the patient returned on November 11, the wound was found very raw, inflamed, foul smelling, and exuding pus. Much of the new skin that had been laid down sloughed off, and re-hospitalization was advised.

On November 16, 1938, he was readmitted for the third time. The wound at this time was very red, indurated, and weeping.

Cultures, taken on admission, for some unknown reason yielded no growth aerobically or anaerobically. Continuous hot compress treatment was instituted. In 2 weeks there was no diminution in the size of the ulcer, so wide excision of scar and indurated tissue was done and an attempt made to close the popliteal space by suturing. Within 2 days, however, there was almost complete destruction of the skin edges, with suppuration, and most of the sutures had pulled out. All sutures were removed and hot compresses were reapplied, until the wound became clean. The edges were very red, blending with a purplish discoloration of the skin beyond. A clinical diagnosis of chronic burrowing ulcer was made at this time, and it was decided to employ zinc peroxide cream. Daily dressings, with the zinc peroxide freshly prepared and well sealed with a thick vaselined gauze, were begun. Within a week the wound had healed considerably. The purplish discoloration had largely disappeared. The base had taken on a clean, healthy, pinkish granulation and suppuration became progressively less. On December 28, 1938, as no undermining was evident and new skin could be seen to be growing in from the margins, and as it appeared that all foci of infection had been obviated, 15 skin grafts of the Reverdin type were placed on the ulcer bed. All of the grafts were successful. No infection was seen. The patient was allowed out of bed, the knee immobilized by an anterior splint. On January 10, 1939, a slight serous discharge was discovered around the crust surrounding the most distal grafted portion. On lifting the crust, the epithelium around the grafts had broken down, denuding a large area. Cultures were made and yielded a hemolytic streptococcus and *Staphylococcus albus*, aerobically. No strict anaerobes were recovered. Zinc peroxide treatment was resumed, and in 10 days most of the wound was again epithelized. By February 1 the wound had healed entirely and no further dressings were applied. Patient was discharged, well. He was seen weekly for 3 weeks thereafter. No recurrence.

CASE 6 Reg. No. VII 7469 C H aged 53 years white male was admitted to hospital February 7 1936 discharged March 9 1936 Result improved

Three weeks prior to admission, the patient as truck on the right shin, abraded the boot the size of a half dollar. After a few days the spot turned black and crust formed over it. His physician lifted off the crust and applied an ointment. The lesion then began to extend, and within the next 3 days punched out ulcer formed which as very painful especially when the limb as dependent. A cellulitis developed, involving the leg from the toes to the upper third. Several days later he developed chills fever and sweat ng, accompanied by a swollen gland in the right groin. He kept the leg elevated, applying the medication prescribed. In spite of this the ulcer enlarged, exposing the tibia and later the muscles of the calf. A purulent discharge as copious. A small, dirty bluish area developed just lateral to the ulcer with perforation from beneath, and extension till it merged with the larger ulcer. The physician then sent him to the hospital.

Examination at this time disclosed swelling of the right leg, extending from the metatarsophalangeal articulations to the upper third of the leg. This swelling pitted on pressure. The skin was reddened and tender. There was a ulcerated area about 3 inches in diameter and roughly circular in outline on the anterior surface of the leg, about the middle exposing the tibia and the muscles of the calf. There was frank suppuration from the base of the ulcer. No cultures were taken at that time. There as painful, right, unequal edema. The temperature was 100 degrees on admission and fluctuated between 98 and 100 degrees for the ensuing 4 days. The white blood cells numbered 6000. Blood Wassermann and Kahn tests were positive.

With the application of hot saline compresses the cellulitis disappeared, and after 2 weeks suppuration ceased entirely leaving the ulcer base clean and granulating. Gentian violet and tight dressings were applied daily. On March 3 1936 he as discharged in care of the out patient department where he received ultraviolet therapy by means of quartz bulb.

He as readmitted on May 3 1936 (Reg. No. VII 40) extension of the ulcer down and. Ultra violet therapy and local applications had been ineffective. The ulcer base as then scarified, and many small punch grafts were applied. He as discharged on May 13 1936 improved.

Because the on dependent suppuration the patient became discouraged. His private physician and as given therapeutic roentgen radiation. This no benefit and loss of the punch grafts which had apparently taken. The diagnosis of varicose ulcer as then made and sponge pressure bandage as applied. The ulcer responded ill for time but few weeks it began to spread, the suppuration on. He was readmitted on July 5 1936 (Reg. No. VII 539). The ulcer now measured by 3 inches

and a shallow and not undermining. Continuous hot compresses were applied with beneficial result. The thought that the ulcer could be on circulatory basis prompted parvaer section pressure treatment in conjunction with the application of local antiseptics. Slow healing as noted and the ulcer diminished markedly in size. On September 7 1936 some inflammation with fluctuation developed to the upper margin, and on pressure pus could be expressed. There is no record of cultures having been taken. Hot saline compresses were not effective and incision with drainage was necessary. Profuse suppuration and irregular temperature elevation persisted for several days, with gradual subsidence and partial healing, until the ulcer became quite small again. He was discharged on December 6 1936 improved, in care of the out patient department. He as dressed three times weekly. Nevertheless the ulcer started enlarging and he readmitted February 1 1937 (Reg. No. VII 7469). The ulcer now measured 7 by 3 1/2 inches, its edges undermining and surrounding tissues dark and equisitely tender. The base as grayish with areas of sloughing and there was a to copious secretion. Parvaer treatment was again tried in conjunction with the application of asochloramid. Cellulitis of the entire leg followed and was successfully combated by elevation and compressing.

A spinal fluid Wassermann as negative. Aerobic culture from the wound yielded Streptococcus hemolyticus and Staphylococcus albus. No anaerobic cultures were made. Hot compresses were reapplied. A small abscess formed beneath and behind the internal malleolus which as incised and drained. Aerobic culture of the pus yielded Streptococcus hemolyticus and Staphylococcus albus. The foot pressing gradually cleaned up the wound the results as healing. On April 20 1937 full thickness skin graft was planted on the ulcer. Within few days these appeared infected and sloughed off. With hot compresses the ulcer again became clean. Codliver oil dressings seemed to promote rapid epithelization and gradual healing. The ulcer had all but healed. A elastoplast bandage was applied and the patient as discharged on September 20 1937.

He as readmitted on October 5 1937 (Reg. No. VII 47), complaining of increasing pain over the ulcer site. The ulcer had regressed so much that the tendons were exposed and appeared to be infected. X-ray suggested penetration of the tibia. No cultures were made. On November 3 block dissection of the ulcer including the exposed tendon, as done and the leg was placed in cast. However the wound continued to slough and 3 weeks later further debridement as performed. Distal union ineffective. In spite of further debridements the infection continued unchecked and on January 4 1938 the leg amputated just below the tubercle of the tibia. Within short time the stump became infected, which as not halted by irrigation, drainage, and debridement and it be

came necessary to reamputate, this time to the level of the supracondylar area. This wound too became infected within a short time. Culture of the pus showed hemolytic streptococcus and Staphylococcus albus predominant. No anaerobic cultures were made.

After compressing until the wound appeared fairly clean, zinc peroxide emulsified in water to the consistency of a cream was placed in contact with the entire raw surface and a dressing was applied. (No attempt was made to keep the dressings moist, the patient stated that the material would cake hard until it was like plaster. He stated further that change of dressings was very painful.) Such dressings were applied daily for a month. In spite of the fact that no effort was made to seal the wound completely so as to prevent evaporation and in spite of the trauma attendant upon change of dressings, healthy granulations increased and there was considerable epithelization. For the first time a treatment was successful in maintaining a clean wound. At the end of the month's treatment, granulations had filled in the ulcer bed almost completely and only a small denuded area remained. There was no subsequent breakdown and at his own insistence the patient was allowed to go home on September 16, 1938. He was seen at irregular intervals in the outpatient department where he was redressed with local antiseptics. He was readmitted on January 16, 1939, with ulceration of the stump through the entire skin thickness. In addition there were two large, shallow, roughly circular ulcers on the flexor surface, edges rolled and somewhat undermined, base covered with pale, rather shaggy granulations. These were within an area of scar tissue equivalent in size to the original area of denudation. This scar tissue was red and not tender. A culture taken from the ulcer edge yielded *Streptococcus hemolyticus* and *Staphylococcus aureus* aerobically and no strict anaerobes. The wound was dressed daily with freshly prepared zinc peroxide cream and sealed off with thick vaselized gauze. Within a week the ulcers were clean and more shallow due to the filling in of fresh healthy granulations, and reduced in size by epithelization from the edges. Undermining was no longer evident. Culture on January 27, 1939, yielded *Staphylococcus albus* and *Bacillus subtilis*, aerobic and no strict anaerobes. However, the surrounding scar tissue appeared more injected than normal and therefore the zinc peroxide treatment was continued. By February 10, 1939, the ulcers had filled in almost to the level of the surrounding scar tissue, which was assuming a more pinkish color. There was no exudation whatever from the base.

The patient was discharged at this time with the understanding that he was to return daily for zinc peroxide dressings.

He continued to do well until March 8, 1939, and gradual regression in the size of the denuded areas was noted. On March 8 he failed to appear. It was then learned that the patient was in such financial

straits that his entire care had to be assumed by a city relief agency, whereupon he was sent to a municipal hospital for treatment.

EVALUATION AND SUMMARY

The 6 case abstracts presented are typical of chronic, undermining, burrowing ulcer caused by a micro-aerophilic hemolytic streptococcus. The modes of onset included contamination of a pre-existing skin abscess (Cases 3, 4, 5), skin abrasion (Case 6), and puncture wound (Case 1). In Case 2 the origin of the disease is not certain although infection of a skin abrasion is suggested.

Pre-eminent is the fact that these infections went along for indefinite periods unrecognized as to etiology. The physicians who first saw the patients believed that they were dealing with ordinary slow-healing wounds. The patients were hospitalized only after trial and failure of the customary methods of treatment. The diagnoses were in many cases revised with lack of success with one treatment and substitution of another. Thus, lymphopathia venereum, tuberculosis, stasis, and luetic ulcers were mentioned but later excluded, either by absence of positive evidence or by failure of cure with the usual routine care. Possibly because of the infrequency of case reports in literature, chronic, undermining, burrowing ulcer was in no instance mentioned early as a possible diagnosis. Interestingly enough, in 3 of the 6 cases (Cases 2, 3, 6) the diagnosis of luetic ulcer was made with positive blood Wassermann and Kahn reactions in each as supportive evidence. A fourth patient (Case 4) was treated for syphilis nearly 2 years on the basis of one alleged positive blood Wassermann reaction which could not be confirmed on repetition. The fact that these ulcers may improve temporarily under various treatments is misleading and may tend to delay the true diagnosis.

Obviously, the diagnosis of this disease is difficult without adequate bacteriological aid, which includes facilities for anaerobic as well as for aerobic bacteriology. The invasive organism grows much better anaerobically than aerobically, at least early in the disease, and may be missed entirely on the aerobic plates, especially in the presence of rapidly growing

secondary contaminants. The same holds true in long standing infections in which the colonies of hemolytic streptococci growing on the aerobic plates are few in number. It is essential, therefore, that material from the ulcers be planted immediately on media under anaerobic as well as aerobic conditions. Furthermore, it is practicable to advise the laboratory that a search for micro-aerophilic, hemolytic streptococcus is to be made. Other wise the information that hemolytic streptococci were present on anaerobic plates might be obscured. Thus, Cases 2 and 6 while presenting a typical clinical picture for chronic undermining, burrowing ulcer do not have bacteriological proof that a micro-aerophilic hemolytic streptococcus was the etiological agent, in spite of the fact that in certain instances anaerobic cultures were made. For frequently reports of "no strict anaerobes recovered" were returned, stating nothing about the presence of hemolytic streptococci growing on the anaerobic plates and the relative number present in comparison to aerobic plates made simultaneously. The streptococci growing on the anaerobic plates were not routinely tested for micro-aerophilic properties. In numerous other instances no anaerobic cultures were requested. Had more adequate bacteriological studies been made on all of these cases, the likelihood is that an accurate diagnosis would have been possible much earlier in the disease.

To facilitate early recognition of this disease as well as other types of surgical infections, the following routine has been established in this laboratory:

The swabs are plated on blood agar and glucose agar plates. After the cultures are made, a smear is gram stained to see if organisms are present. One such blood plate is incubated aerobically and another anaerobically. A number of methods are employed for securing anaerobiosis, e. g. displacement of rarefied air in jar by nitrogen or carbon dioxide, absorption of air from sealed jar by pyrogallol acid and alkali. Because of its simplicity and ready availability the Spray dish () method is most commonly used. All colonies growing anaerobically are tested aerobically and retested in deep semisolid veal or glucose agar tubes for character of growth. Cultures growing in the top level of the deep agar tubes are called micro-aerophilic. The Spray dish method is satisfactory for routine work

and represents a minimal outlay for doing anaerobic bacteriology.

Case 6 is representative of the way these infections may continue for months or years with extensive destruction of tissues before the true cause is recognized. The disease began as a trivial abrasion and spread with involvement of the surrounding skin and subcutaneous tissues until there was extensive destruction. The failure to heal was attributed to the presence of syphilis. When luetic therapy in conjunction with various antiseptics failed to effect a cure, a diagnosis of stasis ulcer was made and adhered to for a long time. The regressions were explained on the basis of secondary infection. Each time that the acute infection would subside the patient was discharged from the hospital and was treated as an ambulatory case. This happened 6 times.

It was not until the fifth admission that further possibilities were looked into and this after two amputations and several débridements had already been made. An earlier diagnosis might have been made, had there been (1) true appreciation of the clinical manifestations of this infection, (2) consideration of chronic, burrowing indolent ulcer in the list of differential diagnoses and (3) adequate and complete bacteriological studies. If the characteristic features of the disease had been recognized and very careful anaerobic bacteriology had been conducted, it is quite possible that earlier institution of zinc peroxide treatment would have saved this man a limb.

The economic aspect of this case merits consideration.

This patient was a machinist earning \$3.00 to \$4.00 per week, but at the time he became lost postulated, he had been averaging only 3 to 4 days work per week. His mean weekly wage on this basis was \$24.00 per week. To date he has been idle 137 weeks and his loss of income for that period totals \$3,288.00. In the first part of the illness he spent \$200.00 of personal savings and members of the family contributed \$274.00. He was hospitalized 6 weeks at cost to the hospital of \$1,097.50.

I recapitulation

Patient's wage loss	\$ 35.00
Patient's savings used	200.00
Cost to family	274.00
Cost to hospital	1,097.50

Total

\$4,107.50

The ultimate cost of the loss of the limb and the necessary rehabilitation is difficult to estimate.

The loss of morale observed in each of these cases is noteworthy, as is the intense discouragement due to repeated disappointment in the various treatments.

Concerning treatment, the failure to obtain permanent improvement with ordinary measures, in spite of careful supervision is brought out in the case summaries and serves as the most forceful argument for the urgent need of early diagnosis. Yet when potent, freshly prepared zinc peroxide cream (6) is carefully applied to all affected parts of the wound and the application protected against drying, the effect is dramatic. Within a few days the exudation ceases, granulations start filling in, the undermining becomes less, and the wound takes on a healthy appearance.¹

Case 1 is of especial significance in its failure to show this typical response. This case illustrates deep invasion into the axilla with involvement of the lymph nodes and undermining of the muscles and tendons. One of the first conditions for the successful use of zinc peroxide is that the preparation must reach all parts of the wound. In this case complete exposure was not obtained in that the muscles and tendons were not severed and the sinuses had burrowed deeply beneath them. These were injected but it is probable that the foci of infection were not reached. This is especially true when the infection invaded the spinal muscles.

The second prerequisite for good results in zinc peroxide therapy is that an effective or potent preparation must be used. When treatment in Case 1 was first instituted, the zinc peroxide employed was a commercial preparation obtained in the open market. When no benefit whatever could be observed from its use, Dr. Meleney was consulted and he forwarded some of the tested material. However, by the time an effective preparation was procured, the destructive process had already spread so considerably and with even deeper

burrowing that complete exposure by débridement was impossible. It is quite possible that, had an effective preparation been obtained earlier in the disease and had more attention been paid to the necessity for flooding all affected parts of the wound with the cream, the progress of the ulceration might have been arrested.

CONCLUSIONS

- 1 Six cases have been presented showing the typical clinical characteristics of chronic undermining, burrowing ulcers due to the micro-aerophilic hemolytic streptococcus.
- 2 The importance of early diagnosis through recognition of the clinical manifestations, and isolation of the micro-aerophilic hemolytic streptococcus by securing anaerobic as well as aerobic cultures routinely, has been stressed.
- 3 The cost of delayed diagnosis is illustrated.
- 4 A simple technique for doing anaerobic bacteriology is suggested.
- 5 The favorable influence of properly employed zinc peroxide therapy as observed by Meleney, is confirmed.

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¹Meleney and Harvey, *Ann Surg.*, 1939, 110, 1067-1094, have found that peroral administration of sulfanilamide in conjunction with the use of zinc peroxide hastens the process of healing in many cases of chronic, undermining burrowing ulcer.

THE CLINICAL USE OF GONADOTROPIC HORMONE FROM PREGNANT MARE SERUM

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THE dominant rôle played by the anterior lobe of the pituitary gland in controlling ovarian activity has been recognized since 1917 when the experiments of Aschheim and Zondek in Germany and of Smith and Engle in this country were published. Until recently however no gonadotropic hormone has been available clinically which reproduced the effect of the anterior lobe of the pituitary. The anterior pituitary-like substances from pregnancy urine while of clinical value do not result in normal ovarian stimulation. They do not stimulate follicle ripening or produce ovulation. Their effect is presumably the production of luteinization although this action is not constant in the human subject (Roas and Hamblen, 9). The urine of women in the postmenopausal period contains a different type of gonadotropic substance which in the hypophysectomized rat stimulates follicle growth to the point of maturity but does not result in ovulation or luteinization.

The accumulated evidence suggests that the cyclic activity of the ovary depends upon the concurrent action of the follicle stimulating and luteinizing fractions of the anterior pituitary lobe and that ovulation is the result of a proper balance between these two types of gonadotropic material.

In 1930 Cole and Hart observed that for a short period of time a gonadotropic substance was present in high concentration in the blood of pregnant mares reaching a maximum concentration about the seventieth day of gestation. Cartland and Nelson have purified this substance by fractional precipitation with acetone or alcohol removal of impurities by adjustment of the acidity and final precipitation in an increased concentration of acetone or alcohol. The purified material is stable as a

dry white powder essentially free of serum proteins and non toxic.

The hormone is assayed biologically by a method based upon the increase in the weight of the ovaries in immature rats. One rat unit is the total dose which, administered subcutaneously in daily divided doses to 21 to 23 day old female rats weighing 30 to 40 grams, will produce a pair of ovaries weighing 65 grams. This must be five times the weight of the ovaries of the uninfected control animals. The various authors are not in agreement as to the most accurate method of standardization of gonadotropic hormones. Moricard and Gothé discussed the standardization of pregnant mare serum hormone and have constructed curves showing the relation of the logarithm of the dose to ovarian and uterine weights of mice. They propose two units: (a) the opening of the vagina in 50 per cent of mice, the fivefold multiplication in the weight of the uterus in 10 mice; (b) constant keratinization of vagina, the fifteenfold multiplication of uterine weight, the threefold multiplication of ovarian weight (0.5 gamma). Heller, Lauson and Sevringhaus found that the uterine weight was the most satisfactory end-point.

The hormone may be administered safely either intramuscularly or intravenously. We have routinely tested all patients for protein sensitivity by intradermal injection. One patient developed a skin rash during the course of intramuscular treatments. This disappeared in 4 to 5 days and did not recur during a subsequent course. One patient who received the hormone intravenously exhibited a reaction thought to be psychogenic and it did not recur with later intravenous injections. No other difficulties have been encountered in the course of several hundred intramuscular and intravenous injections.

A number of experiments have been recently reported which indicate that the gonad

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otrophic hormone from pregnant mare serum unquestionably induces growth of ovarian follicles and ovulation. Hartman was able to induce follicle growth and ovulation in a number of monkeys sexually inactive over a period of months. Although his results were far from promising, this was the first time artificial ovulation has been possible in the monkey. More recently, in an as yet unpublished experiment, he induced multiple ovulations in a bitch during the anestrus period and recovered 12 ova from the fallopian tube. He noted that the uterus of the bitch showed little change. This fact would indicate that ovarian stimulation had proceeded so rapidly that the uterine mucosa could not keep pace with these ovarian changes. The author noted this inability of cyclical events to keep pace with one another in previous experiments and remarked that "the production of ovulation does not guarantee an endocrine condition favorable to implantation of the fertilized ovum."

Foster and Fevold studied the follicle stimulating and follicle luteinizing effects of gonadotropic substances. They found that in the juvenile rabbit, follicle stimulating fractions injected subcutaneously produced only follicle growth but with a trace of luteinizing fraction spontaneous ovulation occurred. Increased amounts of luteinizing hormone failed to produce ovulation but resulted in follicle atresia, cystic degeneration, and luteinization. Pregnant mare serum when administered subcutaneously, caused follicle growth but intravenously produced ovulation. Furthermore, when pregnant mare serum was added to the follicle stimulating fraction, ovulation resulted. These experimental observations confirm the dual action of anterior pituitary lobe substance in the production of normal ovulation. The mode of administration and the correct dosage are likewise of the utmost importance in the success of gonadotropic therapy.

Casida brought calves to ovulation by the subcutaneous injection of pregnant mare serum for 6 days. He also produced ovulation by the subcutaneous administration of follicle stimulating hormone for 2 to 6 days followed by luteinizing hormone on the seventh day.

Davis and Koff reported in 1938 the production of ovulation in women by the intravenous

use of the gonadotrope from pregnant mare serum. This work has been recently confirmed by Siegler and Fein. Thus, it has been possible for the first time to produce artificial ovulation in the human and in the monkey by gonadotrope stimulation.

These selected references throw considerable light on the action of the gonadotropic hormone from pregnant mare serum. In the first place, it combines in the correct proportions the follicle stimulating and follicle luteinizing actions. In this it resembles the action of the intact anterior pituitary lobe or extracts and implants of the lobe. It probably represents the basic gonadotropic hormone being derived from the serum. The gonadotropic substances in pregnancy urine, in the urine of the postmenopausal period, and from other sources may represent metabolically changed products which have lost some of their activities. Recent progress in the metabolism of the estrogens and progestin would indicate that comparable changes may take place in the metabolism of the gonadotropic substances. Chemical studies of the estrogens have clarified the various estrogenic principles derived from the urine, the serum, the follicle, and other sites. Many of these fractions represent metabolically changed products. Pincus and Zahl found that estrone is converted into estrinol under the influence of progesterone. Thus, estradiol is the primary or true ovarian hormone produced in the follicle. Estrone and estrinol represent conversion products. Venning and Browne have shown that the breakdown product of progesterone appears in the urine as the biologically inactive substance pregnandiol glucuronide. It is possible that the urinary gonadotropic fractions represent metabolically changed products and that the serum gonadotropic fractions more nearly represent the gonadotropic principle of the anterior lobe of the pituitary. These and other interesting problems await the isolation of the pure gonadotropic hormone and its chemical synthesis.

The correct mode of administration of this active substance holds the key to successful clinical therapy. The experiments previously cited and numerous others indicate that the amount of hormone, the route by which it is



Fig. 1. left. Endometrium 4 days before onset of menstruation shows prophase three phase without evidence of corpus luteum activity.

Fig. 2. Biopsy March 14, the first day of menstrual period, reveals an anovulatory type of endometrium.

administered and perhaps the proper timing in the cycle may be of the greatest importance. The gonadotropic action of the intact anterior pituitary lobe varies to a considerable extent. It is depleted following coitus in the rabbit and is restored in 24 hours (Friedman and Friedman). Apparently ovulation and depletion of gonadotropic activity in the anterior lobe coincide. These delicate physiological mechanisms are difficult to reproduce artificially and make substitution therapy increasingly difficult.

Were we to have a pure gonadotropic hormone for clinical use we would still have considerable difficulty in developing successful therapy. Too little is known about the endocrine disturbances which lead to a disturbed sex function. The gynecologist is most often confronted only with symptoms in the form of a disturbed menstrual function. Gross examination of the reproductive organs reveals little if any positive information in most instances. The disturbance in physiology may be due to a disordered endocrine balance but that is only the beginning of the problem. The frequency of excellent results with thyroid therapy in some patients with profuse menses and occa-

sionally in patients with amenorrhea is indicative of the importance of the thyroid gland in the endocrine balance of the reproductive organs. The adrenal glands likewise play an important rôle. The amenorrhea of the young woman may not be due to an abnormal anterior lobe of the pituitary gland. It may be due to abnormal reception of the pituitary stimuli as in the presence of refractory ovaries, the absence of normal ovarian tissue or other essential portions of the genital tract.

Careful studies of the cyclical changes in the reproductive organs have correlated the changes in the ovary, the uterus and the vagina. Thus the endometrial pattern reflects in a way the stage of follicle development in the ovary and the ovarian changes indicate pituitary function. These endometrial changes represent one way of determining endocrine function. This is a rather crude diagnostic procedure but accurate endocrine assay particularly for equine gonadotropin is still clinically impractical. The endometrial picture of ovarian-pituitary function is fairly reliable when typical but it may be less valuable in the borderline problems. It can be said therefore that the endometrium mirrors the

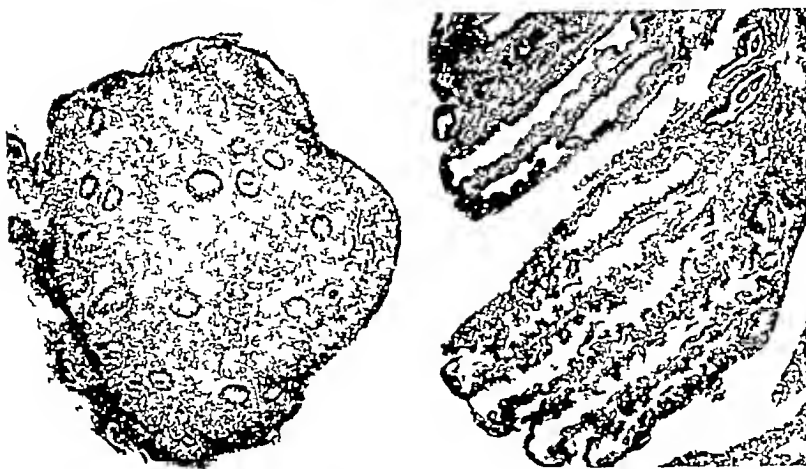


Fig 3, left Biopsy of the endometrium taken on October 6 before therapy was instituted on inactive phase The few small glands are lined by cuboidal epithelium

Fig 4 Specimen removed November 9 after gonadotropic stimulation The endometrium is in the typical late secretory phase

activity in the ovary and pituitary The use of frequent biopsies of the endometrium for an evaluation of endocrine problems and therapy has become very popular clinically It is usually assumed that the proliferative phase of the endometrium represents follicle growth and estrogenic stimulation whereas the secretory phase represents corpus luteum development and progestational stimulation These latter findings are likewise indicative of ovulation This indirect evidence of ovulation is the most important clinical evidence available at the present time

The outstanding discovery of Venning and Browne that the glucuronidate of pregnandiol is a breakdown product of progesterone has provided an additional means of clinical diagnosis The concentration of this substance in the urine is probably a reliable index of corpus luteum activity In the absence of ovulation there should be little or no pregnandiol in the urine It will require considerable evidence to determine the value of the determination of pregnandiol in the diagnosis of endocrine problems

The selection of patients for gonadotropic therapy should be carried out most carefully in order properly to evaluate the results Suitable candidates are not numerous if one is to attempt a careful study During the last 2

years we have accumulated a group of patients in whom pregnant mare serum was used with varying degrees of success Some of the results were spectacular, others were dismal failures Our greatest difficulty was the selection of patients in whom gonadotropic therapy was likely to be beneficial

Sterility patients represent a most interesting group for therapy However, difficulty arises from the fact that only a small fraction of these women are sterile because of a failure of periodic ovulation The most careful investigation is necessary to select the few women in whom a lack of normal ovulation is the important factor in sterility If repeated biopsies before the onset of menstruation or better still, the first day of menstruation to avoid the possibility of disturbing an early pregnancy, fail to show a well developed progestational phase one can assume that the bleeding is anovulatory in origin Israel and Mazer report that endometrial studies in 36 of 109 regularly menstruating sterile women showed absence of ovulation

Such sterile patients should be completely investigated to determine the presence of other factors contributing to the failure of conception Complete general examination of the male partner as well as of the woman should be performed Local genital tract disease



Fig. 5.



Fig. 6.



Fig. 7.

Fig. 5. This specimen of endometrium removed November 3 during the early period of therapy shows proliferative phase.

Fig. 6. A specimen of endometrium from same patient

as in Figure 5 removed 5 days later showing progesterone change.

Fig. 7. Biopsy from endometrium of same patient 3 days before next menstrual period shows typical secretory phase.

should be investigated. The presence of normal active spermatozoa should be established. The patency of the fallopian tubes should be tested. Basal metabolic rate determinations on both husband and wife are indicated.

In this group of sterile patients with failure of ovulation, experimental evidence indicates that the gonadotropic hormone from pregnant mare serum should be given during the late proliferative phase with an abrupt increase in dosage at the time when ovulation might be anticipated. In most instances we have given intramuscularly 20 rat units of the gonadotropic hormone on the ninth, tenth, and eleventh days following the onset of the menstrual period with 60 units intravenously on the twelfth day.

Hartman pointed out the fact that the production of ovulation is not necessarily synonymous with successful implantation of the fertilized ovum. Overstimulation may speed the process so that the endometrial changes fail to keep pace with ovarian activity. Such overstimulation may result in the production of atretic or cystic follicles or the imprisonment and ultimate degeneration of the ovum. That

such an event does occur has been amply demonstrated in the experimental animal. Occasionally menstrual bleeding starts several days or even a week early in patients treated with the gonadotropic hormone. This may indicate a disturbed cycle as the result of degenerative changes in the ovarian follicle. It usually is well to wait a month or even two before resuming gonadotropic stimulation.

STERILITY

The following patients are illustrative of the group of sterile women who have been treated with gonadotropic hormone from pregnant mare serum.

CASE R. R. Unit N. 87595. The patient, aged 35 years, complained of infertility for over 10 years. Visualization of the reproductive tract revealed normal fallopian tubes. The uterus grew irregular as result of small fibroids of the corpus. A biopsy of the endometrium taken 4 days before the February menstrual period revealed complete absence of progesterational changes in the endometrium (Fig. 1). She received gonadotropic therapy for a period of 5 months. During September she was given 20 units of gonadotropic hormone intramuscularly on the seventh, eighth, ninth and tenth days of the cycle and 60 unit intravenous on



Fig 8

Fig 8 Endometrial biopsy removed on August 31 before the onset of therapy reveals a marked hyperplasia of the endometrium



Fig 9

Fig 9 A second biopsy obtained 14 days before onset of the eleventh day No subsequent menstrual periods occurred She was delivered at term of a healthy baby by cesarean section on May 19, 1939

CASE 2 E L Unit No 187037 The patient, aged 22 years, was sterile for $2\frac{1}{2}$ years Her men-

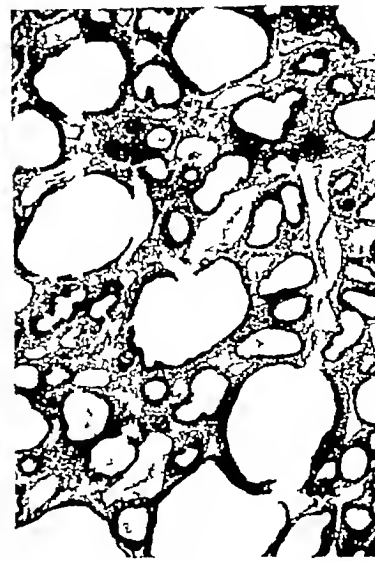


Fig 10

a 3 day period in April shows a well developed proliferative endometrium

Fig 10 Typical well marked hyperplasia of the endometrium before the onset of therapy

strual periods have always been irregular with the interval varying from 28 to 56 days An endometrial biopsy taken in January on the eighteenth day of a 37 day cycle revealed a proliferative phase in the endometrium with no evidence of secretion In

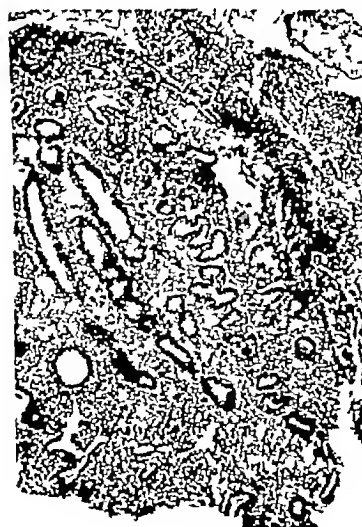


Fig 11

Fig 11 The initial biopsy specimen of endometrium indicates that the uterine bleeding is probably anovulatory in character



Fig 12

before a period in March reveals a typical secretory endometrium

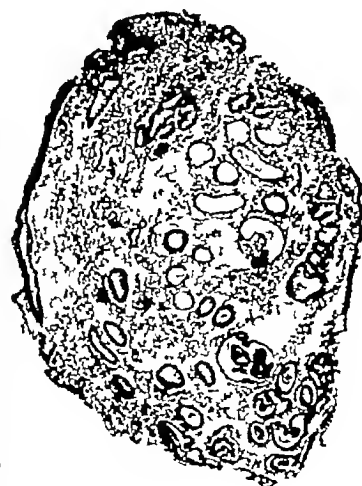


Fig 13

Fig 13 Biopsy before treatment during next cycle shows a very inactive endometrium



Fig. 4. Left. Endometrial biopsy during period of irregular bleeding as described in the text is not associated with ovulation.

Fig. 5. Biopsy 4 days after cessation of normal period in December shows proliferative phase in the endometrium.

March a biopsy taken during the first day of the menstrual flow revealed a typical proliferative phase in the endometrium indicative of the absence of ovulation (Fig. 4). Given 3 intramuscular injections of 20 units each of gonadotropic hormone, days 8, 9, and 10 intravenous injection of 60 units on day 10. No further periods. Delivered of living baby Jan. 1939.

CASE 3. A. S. Unit No. 83789. The patient aged 30 years, complained of involuntary sterility for 7 years. She had single menstrual period time ago of 7 following which he had no periods for year. During the past 7 years her menstrual periods have been very irregular occurring at intervals of from 10 to 8 months. An endometrial biopsy taken in October following a amenorrhea of 7 months revealed very inactive endometrium (Fig. 3). She had prolonged menstrual period following 8 daily intramuscular injections of 20 units of gonadotropic principle. She was treated again during the tenth, eleventh and twelfth day of the next period. An endometrial biopsy obtained on the twenty third day revealed a typical corpus luteum phase in the endometrium (Fig. 4). Given 4 intramuscular injections of 20 units each during sixth to tenth days of December period. This was the last menstrual period. Delivered prematurely on September 1938.

AMENORRHEA

Associated with the group of patients with amenorrhea there are a variety of endocrine dis-

turbances representing differing grades of failure in the pituitary-ovarian-uterine complex. Milder degrees of failure may be present in the patient who has occasional spontaneous periods with intervals of amenorrhea which may be long or of relatively short duration. This type of patient should not be considered a true amenorrheic and in most cases menstruates infrequently because of a sub-threshold ovarian stimulation. Stimulation of ovarian activity with equine gonadotrope may be possible. The following is illustrative of such a result.

CASE 4. S. B. Unit No. 8682. This patient, aged 27 years, had had one period during the past year—scant 3 day flow in March, 1939. There had been no bleeding for 8 months. When therapy was instituted. Three courses of intramuscular injections of 20 units of gonadotropic hormone from mare serum were given during successive months. Each was followed by vaginal bleeding of 3 to 4 day duration which began from 7 to 10 days following the last injection. Endometrium obtained at the onset of treatment (Fig. 5) showed little activity. A biopsy taken 4 days before the onset of bleeding in November revealed typical secretory endometrium (Fig. 6). Preceding this next menstrual flow the endometrium was again secretory in character (Fig. 7).

In the patients with a more complete amenorrhea we are apt to encounter situations in which the ovary is totally inactive and refractory to stimulation. We may divide these patients into three groups on the basis of their history, physical findings, and from theoretical considerations.

In the first group are patients who have never menstruated and who have failed to develop secondary sex characteristics. In these patients the ovaries have not been stimulated and the genitalia are hypoplastic. If treatment is started shortly after the time when puberty should occur, it may be possible to produce normal development and initiate menstruation. We have been unable to accomplish this result in one patient who has had prolonged treatment.

CASE 5 S B Unit No 150466 The patient, aged 19 years, single, had never menstruated. There was a definite hypoplasia of the genital tract. The uterus was small with a relatively long cervix. Some development of the breasts had occurred. This patient had received various forms of endocrine therapy during the 3 years before she came under our observation. These had included treatment over a 2 year period with thyroxin and theelin. She had also received treatment with prephysin. From March 25, 1937, to May 10, 1937, she received 18 intramuscular injections of 15 units of gonadotropic hormone from mare serum. In August, 1937, she was given 8 injections of 8,000 international units of amniotin in oil, and it was planned to follow these by gonadotropic hormone in the hope that we might in some way produce genital development. She became discouraged, however, and did not report for treatment until 4 months later. During January, February, and March of 1938 she received 4 to 6 intravenous injections of 60 units of gonadotropic hormone from mare serum. We were never able to obtain sufficient endometrium for microscopic study. There was no increase in the size of the uterus and no bleeding. The only subjective symptoms were slight tingling in the breasts on 2 or 3 occasions. She has subsequently been treated by both intramuscular and intravenous administration of the gonadotropic hormone without success.

The second group of patients with amenorrhea consist of those who have never menstruated but do show normally developed secondary sex characteristics. In this way they show evidence of some ovarian activity. These patients may be refractory to treatment, perhaps because of an inability of the ovaries to respond to stimulation. They are not always so, however, as shown by the following record.

CASE 6 R H Unit No 181785 Patient, aged 24 years, has been married 1 year and has had no pregnancies. She had had one 3 day period at the age of 11 years but no bleeding since that time. Treatment consisted of 8 to 10 intramuscular injections of 20 units of gonadotropic hormone each month during 8 months from October, 1937, to May, 1938. On two occasions the gonadotropic hormone therapy immediately followed 160,000 international units and 80,000 international units of amniotin in oil. Bleeding did not result in either instance. Two periods of bleeding did occur during the course of therapy and one period has occurred spontaneously at an interval of 4 months following the cessation of treatment. Endometrial biopsy taken before the onset of treatment showed a simple hyperplasia of the endometrium (Fig 8). A second biopsy taken 14 days before the onset of a 3 day period in April, 1938, showed a well developed proliferative type of endometrium (Fig 9).

The third group of patients are those with complete secondary amenorrhea. In many instances the amenorrhea of this type follows a pregnancy. Sheehan and Murdoch have shown that such a syndrome may be the result of necrosis in the anterior lobe of the pituitary gland. When of this type, it is accompanied by asthenia, hypothermia, apathy, and sometimes weight loss. Perhaps more frequent is the type of patient in whom there is a rapid gain of weight dating from parturition or from marriage. These patients are refractory to treatment with the gonadotropic hormone. Three patients who developed amenorrhea following their first pregnancies were treated intensively with mare serum gonadotropic substance. In 1 patient the amenorrhea was of over 5 years' duration and in the other 2 over 3 years. The onset of menstruation failed to occur in all 3 of these women.

FUNCTIONAL BLEEDING

The last group of patients which we wish to discuss are those who have irregular acyclic bleeding. These are the patients with so called functional bleeding. Functional bleeding in young women probably represents a clinical syndrome in which a failure of ovulation may be an underlying cause. In such cases follicles mature but fail to rupture and release their imprisoned ova. The result is an excessive estrogenic stimulation provided by the unruptured follicles. Irregular and prolonged periods of bleeding characterize this condition.

The endometrial picture is usually typical and consists of an excessively thickened mucosa often polypoid in appearance with glands which vary in size and shape giving the "Swiss cheese pattern" so well described by Novak. Occasionally the endometrium may be early proliferative in type with little evidence of activity. The absence of secretory manifestations on the part of the epithelium in this hyperplastic endometrium is indicative of a disturbed endocrinal balance.

The therapy of this condition has been largely on an empiric basis. With the advent of purified hormones attempts have been made to develop a more rational therapy. Novak and Hurd have reported some success following the administration of gonadotropic fractions from pregnancy urine. The fact that the human ovary does not respond to these substances would indicate that the good effect could not be ascribed to the correction of the endocrinal imbalance. Progesterone has been used in an effort to substitute for a lack of corpus luteum development in these patients. The lack of striking results is probably due to the fact that simple substitution therapy does not correct the disturbed mechanism for endocrinal control of normal cyclical activity. More recently testosterone propionate has been used in the treatment of functional bleeding. Foss, Gaines, Salmon, and Geist, and a number of others have reported that 300 to 1,000 milligrams per month of the male sex hormone inhibits further bleeding and arrests the endometrium in the early proliferative phase. Larger doses cause varying degrees of endometrial atrophy. Associated with these changes evidences of masculinization occur in the form of an increased hair growth in the male pattern, voice changes, and growth of the clitoris. These undesirable side effects may be temporary but they do seriously interfere with the success of therapy.

Theoretically gonadotropic stimulation of patients with functional bleeding should lead to the completion of normal follicle growth, follicle rupture and corpus luteum formation. Such a normal sequence should re-establish regular menstruation. A small group of patients were treated with mare serum hormone with varying results. In a few instances there

occurred a cessation of bleeding and a return to normal menstrual periods. As a group however the results were far from promising.

Spontaneous remissions are not infrequent in the history of this type of disturbance. The following case reports give evidence of an effect produced by the use of the gonadotropic hormone from mare serum.

Puberty is occasionally complicated by very prolonged and irregular periods of bleeding. Adolescent girls may become exsanguinated as a result of the abnormal blood loss. The endometrial picture is similar to that seen in patients with functional bleeding. These changes are probably the result of prolonged periods of estrogenic stimulation. Adolescence represents a period of endocrine imbalance prior to the establishment of regular cyclical activity.

CASE 7. H. R., aged 14 years. Unit No. 101605. The puberty and first menstrual period began on August 4, 1935. The bleeding continued for a period of 8 weeks without interruption. An endometrial biopsy obtained early in September revealed marked hyperplasia of the endometrium quite typical of the Swiss cheese type of Novak (Fig. 1). The patient received 4 intramuscular injections of mare serum hormone 20 units each, followed by intravenous injections of 50 units each at intervals of every other day. This treatment was repeated the following month. Bleeding ceased about 10 days after the completion of the first course of injections, following which normal menstrual periods were established and continued.

CASE 8. D. J. aged 16 years. Unit No. 1050. This patient has had irregular periods of bleeding and amenorrhea during the past 4 years. A dilatation and curettage was performed elsewhere in 1935. Regular periods occurred for a few months following this procedure. There was continued bleeding from September 1936 to January, 1937, repeated from June to September 1937 and from November 1937 to the onset of therapy in January 1938. An endometrial biopsy taken at the beginning of treatment shows a proliferative type of endometrium with some degree of hyperplasia (Fig. 2). Therapy with gonadotropic hormone from mare serum was given during January and February in courses consisting of 7 intramuscular injections of 20 units each. This is followed by courses of 4 intramuscular injections of 20 units each during March and April. The patient had normal periods during the next 3 months. Biopsies of the endometrium taken during the period of treatment are illustrated in Figures 3 and 4.

CASE 9. E. M. aged 16 years. Unit No. 1545. This patient gave history of alternating periods of menorrhagia and irregular and prolonged bleeding.

during the past 5 years. She had been flowing continuously for 2 months when first seen. During a period of 7 months from October, 1937, to April, 1938, she received 6 courses of treatment with gonadotropic hormone from mare serum. Intramuscular injections of 20 units were given daily over periods of from 10 to 3 days, the number of treatments in any one series being decreased as there seemed to be an approach toward regular cycles. A biopsy taken of the endometrium at the onset of treatment shows a little activity on the part of the endometrium (Fig 14). The biopsy taken on December 14, 2 days following cessation of bleeding shows an early proliferative stage in the endometrium (Fig 15). It is apparent from the foregoing that regular cycles were not established although the patient was satisfied that a definite improvement had been produced.

In summarizing this group of clinical observations we wish to make clear that there are many gaps in our attempts to correlate what has occurred with what might theoretically have been expected. We do not wish to give the impression, either, that all of our results have been successful. There have been many failures. We have tried to show the type of endocrine problems in which the gonadotropic hormone from mare serum may be of some use. There is a great deal concerning dosage and the optimum time of administration which remains to be determined. We do believe that this is the most satisfactory gonadotropic hormone at present available.

CONCLUSIONS

1 The administration of gonadotropic hormone from pregnant mare serum has been followed by pregnancy in previously sterile patients in whom anovulatory menstrual cycles have been demonstrated.

2 This gonadotropic hormone has proved clinically effective in some cases of acyclic uterine bleeding associated with evidence of continued endometrial proliferation.

3 Amenorrhea resulting from inadequate ovarian activity has responded to the gonadotropic hormone from pregnant mare serum by the occurrence of uterine bleeding.

4 No untoward effects have been demonstrated either locally or systemically following several hundred intramuscular and intravenous injections of gonadotropic hormone from pregnant mare serum.

5 Further carefully controlled clinical observations are necessary definitely to establish the therapeutic value and indications for the use of gonadotropic hormone from pregnant mare serum.

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A COMPARISON OF THE PROTHROMBIN LEVELS OF MATERNAL AND CORD BLOOD AT DELIVERY

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A RAPID clinical method for the estimation of prothrombin was proposed in 1935 by Quick, Stanley Brown and Bancroft (6, 7) and in 1936 Warner Brinkhous and Smith (14, 15) introduced a quantitative method for the determination of prothrombin. The apparent causal relationship between vitamin K deficiency and prothrombin deficiency on the one hand and between a low prothrombin level and tendency to bleed on the other occasioned new interest in all of the hemorrhagic diseases. Whipple as long ago as 1913 suggested that the cause of the fatal widespread hemorrhages in an infant of 3 weeks was probably an absence of blood prothrombin. In 1937 Brinkhous, Smith, and Warner (1) using their own method found that in 21 newborn infants the plasma prothrombin averaged only about one-quarter that of the normal adult and varied between 14 and 39 per cent of normal. In 1 case of hemorrhagic disease the plasma prothrombin was less than 5 per cent of normal. Employing both the method of Quick and of Warner however Owen Hoffman Ziffren and Smith found that in 38 infants the prothrombin by the Quick test was normal but by the Warner test was deficient. At first Quick and Grossman (8) also reported that in infants the prothrombin level determined by their method was not significantly lowered but in a later communication 3 babies at birth had an average prothrombin level of less than 70 per cent (9). In the case of other infants a marked drop in the prothrombin level apparently occurred on the second day after birth with a rise on the fifth and sixth days. A similar observation was also made by Owen and his co-workers. At about the same time Waddell Guerry Bray and Kelly (2) also using the Quick method, reported improvement in the low prothrombin level of 2 infants after feed-

ing vitamin K and later in a study of 20 newly born infants reported evidence suggesting that 10 of these treated with vitamin K had more plasma prothrombin than 10 untreated controls (13). Recently Hellman and Shettles, using the method of Warner Brinkhous, and Smith, have substantiated the findings of these investigators in that the average prothrombin values in dilution units of 19 full term infants was found to be 22.5. In the case of 9 other infants at varying stages of prematurity the average value of prothrombin was 8.3. At the time of delivery the prothrombin units of the mothers averaged over 100. They were the first to make a direct comparison of the prothrombin levels between mother and child.

The literature concerning the relation between vitamin K and plasma prothrombin has been well summarized in the recent papers of Smith, Ziffren, Owen, and Hoffman and of Butt, Snell and Osterberg.

The data concerning the prothrombin level of newborn infants, therefore is inadequate and conflicting. For this reason it seemed desirable to investigate the prothrombin level not only in a larger series of newborn infants but also in their mothers at delivery. At the time this work was begun the report of Hellman and Shettles had not yet appeared.

METHODS

The prothrombin time by the method of Quick (6, 7) was determined in the case of 50 mothers and 51 babies (including one pair of identical twins) at the time of delivery and in 32 mothers and 33 babies (including the twins) from 7 to 14 days after delivery. In addition at delivery the volume of packed erythrocytes was measured in the case of 39 mothers and babies. Fetal blood was collected in a paraffin-lined beaker from the placental end of the umbilical cord immediately after its section. Mother's blood at this time and

both mother's and baby's blood 7 to 14 days later was collected by venipuncture in clean dry syringes. All blood was immediately mixed with the appropriate amount of oxalate solution. On each day that tests were made, workers in the hospital were used as normal controls.

In all instances, determinations on plasma dilutions of 100, 50, 25, and 12½ per cent were made in the case of controls, mothers, and babies. Higher dilutions were occasionally necessary for interpolation. The prothrombin values of undiluted plasmas and of those of 25 per cent dilution in mothers and babies were calculated by comparison with the normal controls according to the formula illustrated below.

$$\lambda = \frac{p_1 p_2 p_3 p_4}{t_1 t_2 t_3 t_4} \left\{ \begin{array}{l} \text{the prothrombin value of unknown ex-} \\ \text{pressed in percentage of normal control when} \\ \text{the percentage concentrations and the co-} \\ \text{agulation times in seconds, respectively, at} \\ \text{increasing dilutions of the normal control} \\ \text{plasma and when} \end{array} \right.$$

$$t_x = \text{Coagulation time in seconds of the unknown plasma}$$

When t_x lies between t_1 and t_2 then

$$\lambda = p_1 + \frac{p_1(t_1 - t_2)}{t_1 - t_2} \quad \text{If e.g. } t_x = 16 \text{ seconds, then}$$

$$t_1, t_2, t_3, t_4 = 15, 20, 30, 50 \text{ seconds, and}$$

$$p_1, p_2, p_3, p_4 = 100\%, 50\%, 25\%, 12\frac{1}{2}\%$$

$$\lambda = 50 + \frac{50(20 - 16)}{20 - 15} = 90\%$$

RESULTS

The results of these determinations are illustrated in Table I. In the case of the undiluted plasmas, the average prothrombin value of the mothers at delivery was 117 per cent of normal and that of the cord blood was 85 per cent of normal. In the case of the 25 per cent dilutions, however, the values were 140 per cent and 63 per cent of normal, respectively. Since the prothrombin determinations were repeated at 7 to 14 day intervals in the case of only 32 mothers and 33 babies (including the twins), Table II is a comparison of the original prothrombin values at delivery of the same cases which were studied again postpartum. The average values of the undiluted plasmas of these mothers and babies were 107 per cent and 77 per cent and of the 25 per cent dilutions were 133 per cent and 62 per cent, respectively. Likewise 7 to 14 days after de-

TABLE I — COMPILATION OF DATA OF ALL CASES STUDIED

	Prothrombin values in per cent of normal control								Volume of packed erythrocytes in per cent	
	At delivery				7 to 14 days after delivery				At delivery	
	Mother		Child		Mother		Child		Mother	Child
	A	B	A	B	A	B	A	B		
Maximum	300	270	212	108	200	184	150	125	48	65
Minimum	61	64	27	20	55	87	40	33	32	46
Mean	117	140	85	63	102	127	89	82	40	55

A—Undiluted plasma

B—25 per cent dilution of plasma

livery the average prothrombin value with undiluted plasma of the mothers was 102 per cent and of the babies 89 per cent, but with 25 per cent dilutions these values were 127 per cent and 82 per cent of normal, respectively.

Table I shows also that the average volumes of packed erythrocytes in the case of 39 mothers and babies were 40 and 55 per cent, respectively.

None of the babies after delivery showed any tendency to bleed and only 2 cases (cases 6 and 25) were definitely premature. In one of these the prothrombin level was high and in the other low. No definite correlation was found between the prothrombin levels of individual mothers and babies.

ANALYSIS OF STUDY

The Quick test in which oxalated plasma is employed is based on the simple concept that

TABLE II — COMPARISON OF THE PROTHROMBIN VALUES OF THE SAME 32 MOTHERS AND 33 BABIES AT DELIVERY AND 7 TO 14 DAYS POSTPARTUM

	At delivery				7 to 14 days after delivery			
	Mother		Child		Mother		Child	
	A	B	A	B	A	B	A	B
Maximum	250	20	100	100	100	184	150	125
Minimum	71	64	27	20	55	87	40	33
Mean	107	140	77	63	102	127	89	82

A—Undiluted plasma

B—25 per cent dilution of plasma

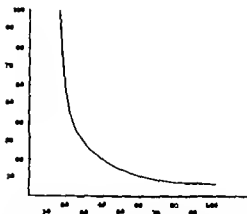
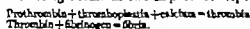


Fig. 1. The average prothrombin curve of healthy individuals (5 men and 5 women). The percentage of plasma diluted with physiological saline solution is plotted against the prothrombin clotting time in seconds. The same thromboplastin solution as used throughout.

blood clotting occurs in two important steps



Since the quantity of plasma fibrinogen would very rarely be altered enough to influence the speed of the reaction and since thrombin probably occurs in stoichiometric proportion to prothrombin the time required for plasma to clot is largely dependent upon the concentrations of the substances in the first part of the first equation. In the presence of an optimum amount of calcium and of an excess of thromboplastin therefore the speed of clotting should indicate the amount of prothrombin. Since the time of the reaction and the amount of prothrombin are not directly proportional to each other a curve showing serial dilutions of normal plasma plotted against the time in seconds should be constructed for interpolation of the time of clotting of an unknown plasma. Furthermore this procedure must be done on each day that tests are made since each preparation of thromboplastin will give a different minimum time with normal plasma and since with time the preparation will deteriorate. The absolute time of clotting consequently is of no value in determining the amount of prothrombin.

The method of Warner Brinkhous and Smith, however is a much more accurate test

for the quantitative determination of prothrombin. These authors have properly criticized the method of Quick in that the test measures not one variable but the sum of two variables because no allowance is made in the first equation for the convertibility of prothrombin into thrombin. This difference undoubtedly explains the varying results with the 2 tests given in the literature. Smith and his associates readily admit, however that the Warner method is too complicated and time consuming for practical clinical use. They and others have also granted the clinical usefulness of the Quick test and have recently proposed a simpler test than that of Quick for clinical use (11). Even though the Quick test measures the sum of 2 variables, for practical purposes, it does measure the effectiveness of the plasma prothrombin in blood clotting and it has been shown that the results of the test can be accurately correlated with a deficiency of prothrombin and vitamin K. Since the purpose of the present investigation was to determine the relative effectiveness of the prothrombin in fetus mother and normal control the method of Quick was thought to be an adequate procedure.

From a typical composite curve of 10 normal controls (Fig. 1) showing the prothrombin time in seconds at varying dilutions, it is apparent that a slight error in reading the time of the unknown undiluted plasma would make a greater percentage error in interpolation if near 100 per cent plasma than if between 12½ and 25 per cent plasma. Owen, Hoffman Ziffren and Smith have also suggested that from Quick's curve dilution should increase the sensitivity of the method. For this reason comparison of the 25 per cent dilutions was made in all cases. It is evident from the results, therefore that the averages of these dilutions for a series of cases give different results from comparisons of the undiluted plasmas. The tendency for the prothrombin values of the mothers to be above normal and for those of the babies to be below normal is increased in the 25 per cent dilutions so that the average difference of 140 per cent and 63 per cent, respectively is significant. However individual cases do not invariably conform with these results. In addition to the

increased sensitivity of the test at these dilutions, it is possible that differences in the convertibility of prothrombin into thrombin, as previously suggested, may be another factor in producing the differences in values

The criticism may be justly made that the formula used for interpolation of the undiluted plasmas and the 25 per cent dilutions is inaccurate since between dilutions the average percentage value of each second's difference in time is employed when in reality on the curve the percentage value of each second between dilutions varies. An error must, therefore, be introduced in the calculations. In our hands, however, the drawing of the individual curves was thought to be attended by even more error than the use of the formula which was of course more accurate in the range of the 25 per cent dilution than in that of the undiluted plasma

Furthermore there is no reliable method for estimating the values of prothrombin above normal even with the use of the curve. Since it has been our observation that the time of clotting of some controls as the plasma is diluted tends to increase in rough arithmetic progression, the values of undiluted plasmas above normal have been estimated by reversing this progression. Thus 200 per cent of normal is represented by the time in seconds of the undiluted control plasma minus one-half the difference in time between the control 50 per cent dilution and the undiluted plasma. Such a method is obviously unreliable and the values above normal recorded for the undiluted plasmas, therefore, are at best only rough estimates

It must also be admitted that another source of error in the test is the use at random of single well persons as controls. Although we agree with Quick that this error is slight, yet a difference between normals of only a fraction of a second makes a large percentage error in the undiluted plasmas. For this reason also a comparison of the 25 per cent dilutions seems preferable to one of the undiluted plasmas. An even better procedure would be to pool the plasmas of several controls

In spite of these sources of error, however, the fact that the prothrombin values of the infants were so consistently less than those of

the mothers and averaged less than those of the controls especially in the 25 per cent dilutions is unquestionably significant. Since the average percentage volume of packed erythrocytes of the umbilical cords was much greater than that of the mothers, moreover, the amount of plasma per volume of whole blood was proportionately less in the case of the babies. The difference in the total prothrombin values for each unit of whole blood must, therefore, be even greater between mother and child than the recorded prothrombin values which have been determined by comparison of equal volumes of plasma

In some of the cases, determinations of the plasma fibrinogen from the mothers and umbilical cords indicated that in the latter the lowered prothrombin values were not due to a lowering of the fibrinogen. Platelet counts on blood from the umbilical cords in a few of the cases also were normal. More detailed reports of these findings will be made in separate communications respectively by Rush and Hodge

The results of the prothrombin determinations which were repeated on mothers and babies at 7 to 14 day intervals show little significant change in the case of the mothers and only a slight average increase in that of the babies. Since prothrombin tests were not done on infants between the time of birth and 7 days after delivery, no evidence was obtained as to whether a fall in the prothrombin values occurs in the interval

None of the mothers received any vitamin K, except in their normal diets, and none of the infants were treated with vitamin K. The elevated prothrombin values of the mothers, however, would not suggest that a deficiency of vitamin K at term was usual

SUMMARY

1 The average prothrombin values of 50 mothers and 51 babies at delivery by the Quick test were found to be above normal in the mothers and below normal in the babies

2 Repetition of the tests 7 to 14 days after delivery in 32 mothers and 33 babies showed no significant change in the prothrombin values of the mothers and only a slight increase in those of the babies

3 The average volume of packed erythrocytes was much greater in the case of 39 babies than in their respective mothers. The discrepancy between the prothrombin values of mother and child must, therefore, be proportionately larger for whole blood than for plasmas.

4 The Quick test is thought to be a reliable clinical procedure, but sources of error in the method are discussed.

5 It is suggested that comparison of the 25 per cent dilutions of unknown and control plasmas gives more reliable determinations than comparison of the undiluted plasmas.

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LUNG ABSCESS

An Analysis of the Massachusetts General Hospital Cases from 1933 through 1937

RICHARD H SWEET, M D, F A C S, Boston, Massachusetts

IN 1925, Lord gave the results of an analysis of 227 cases of lung abscess observed between the years 1909 and 1924 at the Massachusetts General Hospital. A similar study was presented by King and Lord in 1934 based upon a series of 211 cases recorded between the years 1924 and 1932. The present study is based upon the group of cases observed during the 5 year period, 1933 to 1937, inclusive. Since the last mentioned report there have been certain important changes in our experience with the disease. The x-ray studies have become so accurate that the exact location of the abscess has been designated in every case. There has been a tendency to operate earlier in the course of the disease as well as an increase in the percentage of patients operated upon. Furthermore, the technique of the primary drainage operation has been perfected and improved considerably over that used in the earlier series of cases. There has been a slight but definite improvement in the mortality and a large improvement in the recovery percentage figures with a definite lowering of the operative mortality. Several methods of treatment, such as artificial pneumothorax, extrapleural thoracoplasty, and cautery lobectomy, have been abandoned or at least used very infrequently. On the other hand, primary lobectomy by the improved technique now available has begun to be used, and the number of ultimate cures has been increased by the performance of a lobectomy in certain cases in which simple drainage has failed.

In this series a detailed analysis of every aspect of each case has been made, and it is felt that the statistics presented are as nearly accurate as one can obtain. One hundred and

twenty-five cases have been studied and information concerning the end-result obtained in all but 1 (or 124 cases). Certain data such as age and sex incidence are omitted as being of no practical significance.

Scope It must be understood first of all that this report includes all cases of putrid lung abscess whether acute or chronic in which patients were admitted to the hospital during the 5 year period studied. It gives, therefore, the results of our complete experience with the disease during this time.

Definition of lung abscess In going through the record files of the hospital a large group of cases was discovered in which the diagnosis may have been uncertain or confused with some other condition, such as bronchiectasis. These were excluded. The only cases presented here are those in which the patient presented a characteristic clinical history, a foul sputum, and a definite x-ray diagnosis with a cavity and a fluid level. In many, a positive anatomical diagnosis was made at operation or autopsy. For the purpose of this study it is proposed to define an acute abscess as any which has been in existence 4 months or less. Those which have gone more than 4 months are called chronic abscesses. The basis for this division will be discussed (see Chart 6). It is to be clearly understood, however, that this arbitrary definition of the stage of the disease bears no relation to the problem of early versus late drainage which is to be discussed fully under the proper heading.

PREDISPOSING FACTORS

Antecedent disease In general the otolaryngologists have been disinclined to admit that a large number of cases of lung abscess follow tonsillectomy and other operations on the upper respiratory tract. Table I, however,

From the Thoracic Clinic of the Massachusetts General Hospital

TABLE 1—ETIOLOGY OF 125 CASES OF LUNG ABSCESS

	No. cases	Total cases
Operations in the mouth or upper respiratory tract—		
Tonsillectomy	54	
Other operations on the nose and throat—		
Repair of harelip..		
Radical antrum		
Submucous resection		
Excision of nasal polyp		
Excision of nasal hemangioma.		
Radiation to larynx		
Peritonsillar abscess	8	
Tooth extraction	1	70
Various other operations—		
Herniorrhaphy		
Amputation of finger		
Posterior gastro-jejunostomy		
Subtotal gastrectomy		
Hysterectomy		
Cesarean section.		
Appendectomy	2	
Cholecystectomy		
Nephrolithotomy		
Flap operation for varicose veins		
Mastoidectomy	—	4
Normal deliveries		4
Aspiration of foreign bodies		5
Antecedent pneumonia, "cold, or grippé		19
No apparent cause		1
Total		125

demonstrates that of 125 cases 54, or 43.2 per cent, followed soon after a tonsillectomy and 70, or 56 per cent, of the cases had either tonsillectomy or some other operation in the mouth, nose or throat. Only 14, or 11.2 per cent, of the cases followed an operation on some other portion of the body. A few followed normal deliveries or aspiration of foreign bodies. Nineteen, or 15 per cent, followed an upper respiratory infection or pneumonia, and in 13, or 10.4 per cent, no antecedent cause was ever found. In the main, these figures agree with those of King and Lord who found 55.7 per cent of cases preceded by upper respiratory tract operations and 38.6 per cent following tonsillectomy.

FACTORS INFLUENCING THE PROGNOSIS OF LUNG ABSCESS

By a careful detailed study of these 125 cases certain facts regarding the prognosis become clear.

1 *Duration of disease before entry.* The patients in this series first came to the hospital

for treatment at all stages of the disease. By referring to Chart 1 it becomes apparent that relatively few of our operative cases were seen early in the progress of the disease. For reasons to be explained presently the end of the fourth month of the disease has been designated as the dividing line between what may be called an acute and a chronic case. Taking this as the criterion, it is noted that of those patients subjected to drainage, 37 cases, or 47.4 per cent, were acute and 41 cases, or 52.6 per cent, had progressed to a point where they must be classified as chronic before the patients applied for aid. Throughout the ensuing discussion, however except in specified instances, no distinction is made.

2 *Period of observation in hospital before operation.* As a working basis in the management of these cases the policy of the thoracic clinic has been primarily to decide on the merits of each case just what should be done but in general after the expiration of 3 months from the time of onset of the disease the chance of spontaneous cure has been considered to be minimal. Our actual experience has in general supported this belief although the time must be extended to 4 months instead of 3 (Chart 2). It will be seen from Chart 2 that when operation was performed the majority of operations were carried out within the first 4 weeks of observation (59 in all). It is apparent, then, that although our clinic has been regarded as following a decidedly conservative course we have actually operated upon about 73.3 per cent of the cases within 4 weeks of their entry to the hospital, and of these 21 or 35.5 per cent, were operated upon within 8 weeks of the onset of the disease. Making allowance for the fact that a large percentage, approximately 52.6 per cent, of our cases are already chronic when first seen the number of early operations, i.e. those done within the first 3 months of the disease, compares favorably with the statistics of the advocates of early operation (Chart 3) (See Neubof).

The present tendency seems to be to consider 6 weeks from the time of onset as the dividing line between an early operation and a late one. Our experience however has been that very few of our patients come to us

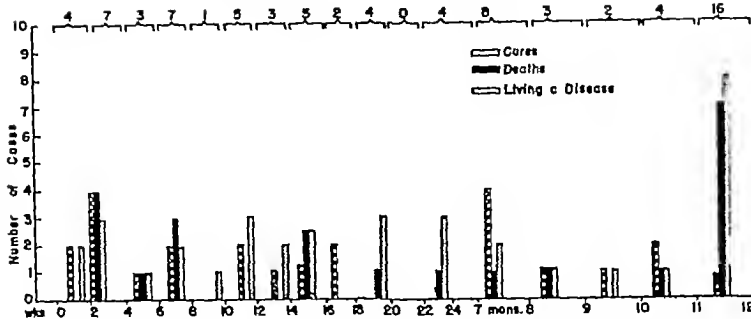


Chart 1 Elapse of time from onset to date of entering hospital in 79 patients operated upon

promptly enough for us to perform an operation so early. In our group of cases only 8 patients were sent to the hospital soon enough after onset for drainage to be carried out before the end of the sixth week. One observes, therefore, that in the majority of cases the delay in instituting early drainage has occurred before the patient came to this clinic. That there has been little delay after arrival at the hospital is shown by the fact that of the 79 drained cases 38 were operated upon within 2 weeks from the time of their admission to the hospital and, as noted, 59 within 1 month from the time of entry (Chart 2). In the majority of these cases the interval of time between admission and operation was used for diagnostic study and investigation to determine the probable prognosis and the necessity for surgery.

3 *Virulence of the infection* The severity of the disease seems to vary from patient to patient corresponding in some little understood way to the variation in the virulence of the organisms and the resistance of the patient. In certain patients the course is unusually benign, some of the spontaneous cures having occurred within a few weeks from the onset. Many of the cures reported after routine early operation may very well be in patients of this type who might have recovered even if not operated upon. On the other hand, some of the patients run an unusually fulminating course. For example, of the 14 cases in which death occurred without operation, 10 died in less than 2 months after the onset of the disease. Many other patients with virulent conditions were subjected to operation and, true to its persistently severe

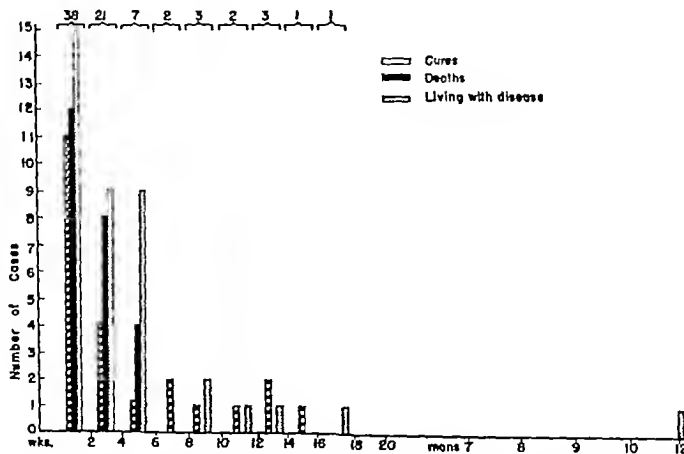


Chart 2 Time date of entry to date of operation. Period of observation before operation in 79 patients subjected to surgical drainage

TABLE L.—ETIOLOGY OF 125 CASES OF LUNG ABSCESS

	No. cases	Total cases
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Posterior gastro-jejunostomy		
Subtotal gastrectomy		
Hysterectomy		
Cesarean section.		
Appendectomy	1	
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Nephrolithotomy		
Flap operation for varicose veins		
Mastectomy	—	14
Normal deliveries		4
Aspiration of foreign bodies		4
Antecedent pneumonia, "cold," or "grippe"		19
No apparent cause		3
Total		125

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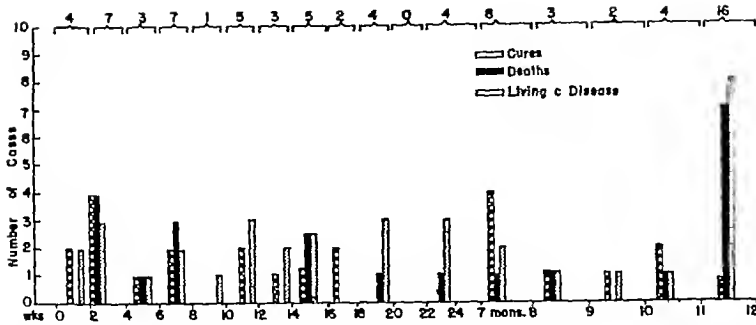


Chart 1 Elapse of time from onset to date of entering hospital in 79 patients operated upon

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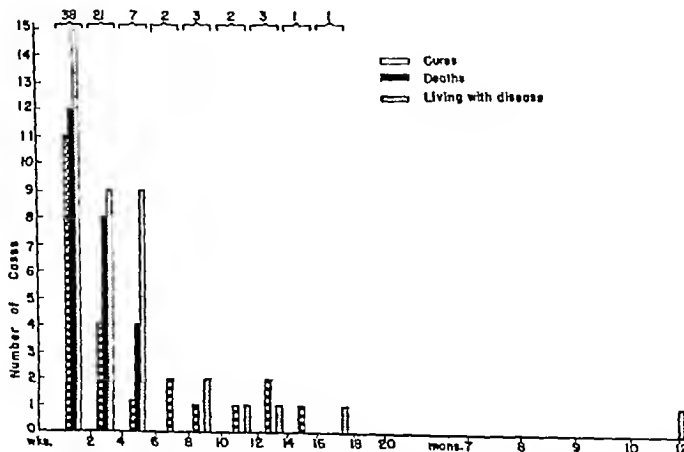


Chart 2 Time date of entry to date of operation. Period of observation before operation in 79 patients subjected to surgical drainage

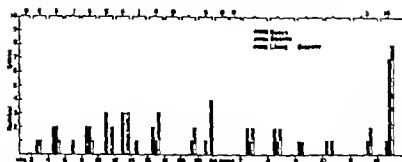


Chart 3. Elapse of time. Onset of disease to date of operation in 70 patients operated upon.

nature, the disease went progressively on, often in spite of multiple operations, to a fatal termination.

4. *Location of the abscess in the lung* King and Lord state that a location at or above the root of the lung is relatively favorable while lesions below this level are less promising. This is based on the cases occurring before the more frequent use of lateral exposures made the x ray localization of the disease so much more accurate. In each of the 125 cases in this present series the anatomical location of the abscess in the lung was accurately determined. In Charts 4 and 5 figures are given to show the numbers which occurred in the apical and lower portions of the right and left upper and lower lobes as well as the right middle lobe. By comparing Chart 4, which presents the location of all the abscesses in the group with Chart 5, which

gives the distribution in the group of patients who were cured spontaneously, one must conclude that there is no significant correlation between the location of the abscess in the lung and the tendency to spontaneous cure.

5. *Prognosis in relation to the stage of the disease* (Chart 6). It would seem to be apparent on the basis of this series that about 49.2 per cent of patients with lung abscess may be cured that 33.9 per cent die and that about 16.9 per cent remain alive with disease in spite of treatment. These figures are based upon the experience of our entire group of 124 completed cases. If on the other hand, the stage of the disease is taken into account, one sees immediately that the prognosis varies from month to month as the disease advances. The importance of more exact knowledge about the prognosis at different stages of the course of the disease is manifest especially

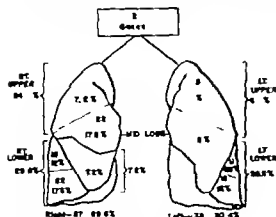


Chart 4. Distribution of abscesses in lung—entire series of 5 cases.

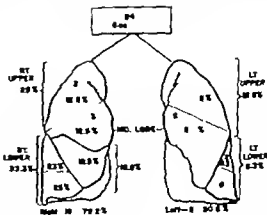


Chart 5. Distribution of abscesses in lung—cured spontaneously.

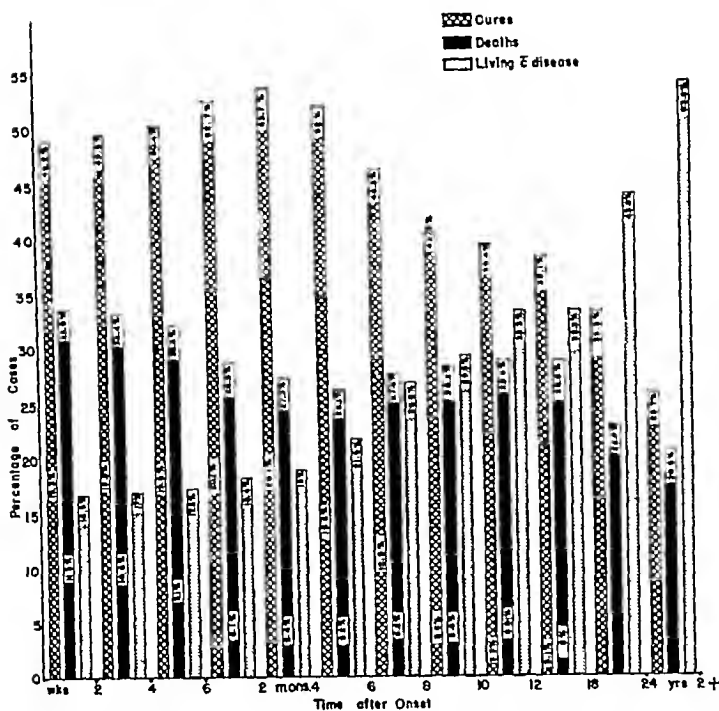


Chart 6 Illustrating the prognosis of lung abscess at various stages of disease from onset to the end of 2 years—Massachusetts General Hospital experience with 124 patients

during the early months when the decision about whether to operate or not is so difficult and so important. Obviously if there is still a good chance of spontaneous recovery, operation should be avoided. But if one can be reasonably certain that spontaneous recovery will not occur, then the sooner an operation is performed the better the chance of cure, the shorter the period of hospitalization, and the smaller the number of complications. This variation of outlook in relation to the passage of time after the onset of the disease is shown graphically in Chart 6. This chart begins with the percentage probabilities of the entire group of 125 cases. Reading from left to right the figures change as a correction is made for each period of time elapsed. In this way from week to week and month to month a new set of percentage probabilities is given as allowance is made for cases dropped out of reckoning because of deaths or cures.

The cases are grouped under the headings of *those who were cured*, *those who died*, and

those living with disease after treatment, with a differently marked block on the chart for each. On the block representing the cured cases, the percentage of expected cures is given at the top; in the lower part of this same block at a proper height, is the figure for the percentage of spontaneous cures. Likewise in the block representing the deaths, at the top is given the total percentage of probable deaths for each period and near the bottom of this block is the figure representing the percentage of deaths expected to occur before an operation could be performed. In the third block, at the top is given the percentage of patients expected to be living with disease in relation to each total group. The grand totals naturally diminish from period to period. All these figures, of course, are based on the actual records of the entire group.

As an example of the way in which this chart is intended to be used, let us postulate the case of a patient who has an abscess of 7 months' duration. Such a patient has sur-

TABLE II.—STATISTICAL BASIS FOR CHART 6

Stage of disease	Cured	T. by cured	Cured spontaneously	T. by cured spontaneously	Cured by surgery	T. by cured by surgery	Died	Left to die	Died before operation	Left to die before operation	Died after operation	Left to die after operation	T. remain alive with disease	Total no. per cent 12 months
to weeks		6		64		27		41		54		26	21	known 124 total
to weeks		64		64		27		41				26		122
to 6 weeks		64		64		27	6	26		27		23	21	11—7
6 to 8 weeks		66		23		27		23				26	21	124—
to months	9	20	7	23		27		26	6	5	24	21	126—1	
to 6 months	1	20	2		2	1		1	6	19		26—16		
6 to 8 months	7	27	6	26		21		21	5	17	21	26—		
6 to 10 months	26					26		26		26	26	21—5		
10 to months		26				24		19		5		26—		
to 12 months	6	24		6		7	15	2	2			21	22—15	
15 to 24 months	6	15		6	16		11		2		2	21	24—	
25 to end of series (20 yrs.)	20	26		26	26	2	2		2	2		26—12		
Total result	61		24		27		41	14		26		21	26—12	

vived beyond the period when some with the severest disease will already have died and has also gone beyond the time when some of the more favorable ones will have been cured. The outlook is obviously different, therefore, from what it would be at the outset. By referring to Chart 6 we learn that this patient has a chance of cure as follows: 46.3 per cent with or without surgery; 12.5 per cent without surgery; a 27.5 per cent chance of death with or without surgery; 6.2 per cent chance of death without surgery; and a 16.2 per cent chance of survival with persistent disease.

Certain interesting deductions can be made from this chart. It is obvious first of all, that the outlook for spontaneous cure remains about the same, approximately 20 per cent, during the first 4 months after onset, but falls off rapidly from that time until after the expiration of 1 year from onset, when no case can be expected to recover without the benefit of surgery. From this we have come to define any case of lung abscess as acute up to the end of the fourth month during which time the majority of spontaneous cures may be expected to occur. After 4 months the cases should be regarded as chronic and reasonable expectation of spontaneous cure abandoned. The majority of deaths in the non-operated upon group occur in the early months but as

would be expected, deaths in untreated cases may occur for a considerable period after onset. Another interesting fact is that even after the passage of 1 year or more there is still from 25 to 35 per cent chance of cure by surgical means. Furthermore of the 21 patients living with disease at the end of the period of observation, only one had not been operated upon one or more times.

For the benefit of those who might be interested to determine how the percentage figures which appear in Chart 6 were arrived at, the actual figures have been arranged in columns and are presented in Table II.

TREATMENT

Chart 7 summarizes the results obtained in the entire group of 124 patients whose cases were followed to completion. From this one will observe that 61 or 49.2 per cent, were cured, 42 or 33.9 per cent, died and 21 or 16.9 per cent, remained alive with disease. These terms must be more carefully defined. No case in this entire study has been called cured unless the patient has remained symptom-free for 2 years or more with essentially normal physical signs and the demonstration of healing by x ray. Many writers on the subject of lung abscess have been content to classify the cases of patients who have not

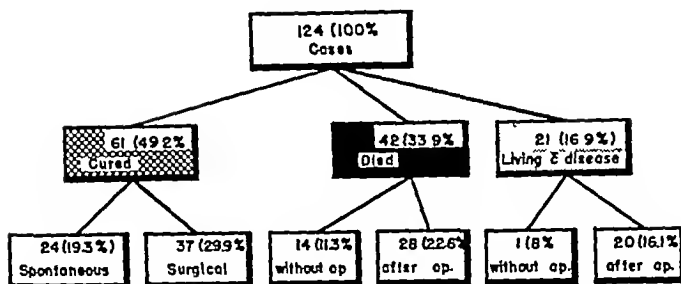


Chart 7 Total experience of 124 patients with lung abscess including all methods of treatment.

died or have been cured as "improved" or "not improved." This is unnecessarily complicated and may lead to a false impression. All those called improved are in constant danger of re-activation and from the standpoint of the result of treatment are no better off than any other uncured case. It seems to be time to abandon this classification and admit that if a patient cannot be called cured according to the aforementioned criteria, he remains uncured. All such cases have, therefore, been grouped under the heading of those who have survived but still have disease. In this group have been placed many who appear on superficial examination to be cured, but who have a persistent or recurrent cavity by x-ray. Some of these were once thought to be cured, but have had a recurrence during the period of observation (2 years or more).

Medical treatment Non-surgical treatment at the Massachusetts General Hospital has consisted of bed rest, attention to nutrition, general supportive treatment, postural drainage, and transfusion if indicated because of anemia. The use of nearsphenamine has been abandoned. Bronchoscopy was used as a method of treatment in only 1 case in this series and that patient was later operated upon and cured surgically. Twenty-four, or 19.3 per cent, patients recovered without surgery.

Surgical treatment Chart 8 illustrates the experience with surgery in the group of 85 patients treated by operation.

The technique of the drainage operation has been improved since the previously reported series. In the majority of cases the

two stage operation has been chosen and performed as follows:

Local and regional anesthesia with procaine hydrochloride is used. After choosing the most direct approach to the region of the abscess, a long incision is made usually parallel with the underlying ribs which are exposed and freed of their periosteum along about 4 to 5 inches of their lengths. If the localization has been accurate the lung and pleura are almost always found to be adherent. Gauze is then packed between the ribs and the underlying periosteum and pleura and also into the remainder of the wound. This constitutes the first stage.

One or more days later, the length of the interval depending upon the nature of the case, the second stage is performed. The packing is removed and the bare ribs are resected. The correctness of the location is then verified by aspiration with a needle and the abscess is opened with the cautery (actual or diathermy) in its most superficial aspect. Enough of the roof of the abscess is then removed with the cautery to allow wide open packing of its cavity. In case the abscess is unusually large, it may be necessary occasionally to remove a segment of one of the adjacent ribs to allow a sufficiently wide opening. The cavity and wound are then packed with dry gauze. No sutures are taken in the wound. This wide exposure of the cavity allows a satisfactory inspection of its interior each time the packing is changed during the next few weeks and if, as often happens, a neighboring subsidiary cavity becomes apparent (as suggested by persistence of fever, cough, and sputum), it is immediately sought for and opened through the wound. Such a secondary procedure done early in the convalescence is considered a part of the primary drainage operation. It has nothing to do with the operation of re-drainage referred to later under the discussion of the treatment of unsuccessful cases.

Past experience with the difficulties of drainage and the low percentage of cures in some of the upper lobe cases has led to the adoption of primary lobectomy in a few selected cases.

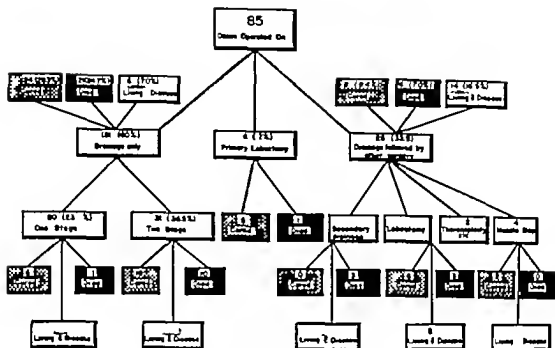


Chart 2. Results in 85 patients operated on.

(6 in this series). Of these 5 were cured and 1 died. All of the 79 remaining cases were treated first by drainage. A brief reference to Chart 9 shows that simple drainage unaided by any supplementary treatment accounted for only 24 or 30.4 per cent cures. Twenty-one or 26.6 per cent, died and 34 or 43 per cent, were not cured by drainage alone. These results are disappointing but undoubtedly bear a relation to the stage of the disease when the operation was carried out and to the severity of the infection.

Operative mortality. It has usually been customary to assume that all the deaths which occurred after an operation had been performed represent the operative mortality. In lung abscess this is not so. As has been pointed out, the virulence of the disease is often intense and many patients die early of the disease whether they are operated upon or not. By a careful analysis of the causes of death in all 21 cases ending fatally after drainage (Table III) it is apparent immediately that the majority of those patients died of the disease. There were 6 deaths, however

which in fairness should be ascribed to the effect of the operation. In Cases 7, 13, 18 and 19 (Table III) the fatal outcome was probably because of the wrong choice of operation or a technical error (Case 13). In Case 2 the avertin anesthesia was probably a contributing factor. In Case 11 death was apparently caused by a pulmonary embolus, a common cause of postoperative death.

Granting that these 6 cases represent the total fatalities resulting from operation per se the operative mortality is 7.4 per cent for the entire group of 79 cases after primary drainage. By referring again to Table III one will see that the causes of death in the 15 remaining cases were spread of infection in the lungs, 7 cases; brain abscess, 5 cases; Streptococcus bacteremia, 2 cases; massive hemorrhage, 1 case. In none of these cases after careful study can the operation fairly be blamed for the result.

One stage versus two stage drainage. Reference to Chart 8 shows that of the 51 cases treated by simple drainage only 20 were done in one stage and 31 by the two stage method

TABLE III—DEATHS AFTER SIMPLE DRAINAGE

Case no	Cause of death	Days after operation	Duration of disease	Extent	Autopsy
1	Brain abscess	16	12 mos	Entire left lung	0
2	Fulminating pneumonitis, aspiration of secretions	2	15 mos	Rt. upper and rt. middle lobes	0
3	Spread to opposite lung septic infarct of kidney	26	5 mos	Large	0
4	Pulmonary gangrene and spreading bronchopneumonia	14	1 mo	Large	+
5	Streptococcus bacteremia	13	6 mos	Multilocular	+
6	Brain abscess	56	8 mos		+
7	Spreading pneumonitis (before second stage)	3	12 mos	Entire lobe	+
8	Spread to opposite lung with empyema (unrecognized)	17	13 mos	Multiple	+
9	Massive hemorrhage	24	7 mos	Multiple	0
10	Brain abscess	28	14 mos	Multiple	0
11	Sudden embolism ? pulmonary	6	4 wks	Large	0
12	Brain abscess	16	4 mos	Large	0
13	Pneumothorax result of one stage operation	11	5 wks	Large	0
14	Amyloid disease. Abscesses in adjacent lung-empyema	4	4 mos	2 large	+
15	One stage operation. Cyanosis ? Spread of infection	5	3½ yrs	Large multiple	+
16	Streptococcus bacteremia ? spreading sepsis in lung	22	5 wks	Large	0
17	Acute mediastinitis Bronchopneumonia	7	2 mos	Large multiple	+
18	Bronchopneumonia spread (before second stage)	2	1½ mos	Multiple	+
19	Trochar thoracotomy (wrong operation)	1	1½ mos		+
20	Spreading infection	2 yrs later	2 yrs	Large	0
21	Brain abscess	7 mos later	10 mos	Large	0

It appears also that the relative number of cures was greater and the number of deaths smaller in the two stage than in the one stage group. This is probably not significant, however, because many of the one stage cases were so severe that immediate drainage was desired so as to avoid any delay. In those that were less fulminating the two stage operation was usually employed.

Our ideas have changed during the past few years. At first we feared entering the pleural cavity in the performance of a one stage operation and this accident occurred in 1 case in this group. Likewise, we used to allow 7 to 12 days or more for the interval between stages. Several patients died, however, of a rapid spread of the infection before the second stage was done. At present our tendency is to use the two stage operation not only because of the danger of entering the

pleural cavity but also to avoid the contamination of the freshly divided tissues of the chest wall. But 24 to 48 hours of contact with a gauze pack is enough to wall off these tissues and the second stage may then be done and the abscess drained much more promptly than formerly. Our recent experience has shown that with accurate localization of the abscess one can find the region where the pleura is adherent, although in many cases the area is small and gauze packing will insure a wider safe space in which to enter the abscess. Our experience confirms the contention of Neuhof that all lung abscesses are peripheral with reference to the lung.

Cases in which secondary operations were performed. An interesting and important problem is presented by those cases in which simple drainage is unsuccessful. Chart 10

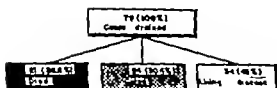


Chart 9. Results after drainage alone.

gives a summary of the treatment and results in the 34 cases of patients left uncured after drainage alone. Six of these were not operated upon again, but are still not cured. Twenty-eight patients were operated upon one or more times after the failure of primary drainage.

Four types of operation were used. In some cases two or more types were used on the same patient. Eleven were subjected to secondary drainage operations. The significant fact about this group is that none was healed by secondary drainage in some cases repeated several times. Three died and 8 were left with disease. *Lobectomy*, performed in this group 11 times resulted in 6 cures, 3 deaths, and left 2 still with disease. *Thoracoplasty* was abandoned early as unsuitable, but in the 2 cases in which it was used, it was un-

TABLE IV—COMPARISON OF RESULTS IN EACH GROUP

	1924-33 Per cent	1933-1942 Per cent
Cured	34.8	40
Died	37	33.9
Alive with disease	28	0
Cured spontaneously	4	9.3
Cured by surgery	8	20.9
Operative mortality (drainage cases)	5	7.4
Number of patients operated upon	45.7	68.5

successful. A *muscle flap operation* was used in 4 cases. In 2 of these a recurrence developed. In one of the latter this occurred 2 years after the abscess cavity was believed to have been closed successfully.

To summarize the results in this group of cases of secondary operation. In spite of every effort only 8 or 21.4 per cent were cured, 6 or 17.4 per cent, died, and 14, or 50 per cent, remained uncured.

Results of surgical treatment by all methods—primary and secondary. The results of the surgical treatment of lung abscess in this series are on the whole rather disappointing. Of the 85 patients operated upon by all methods 37 or 43.5 per cent, are cured, 28 or 32.9 per cent, died, and 20 or 23.6 per cent, are alive with disease. These

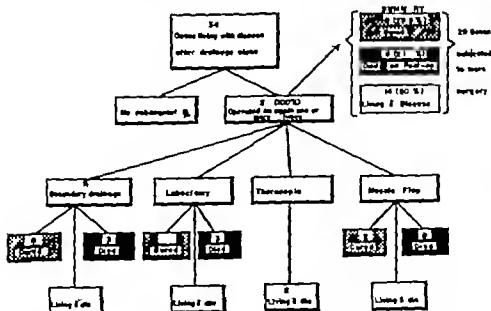


Chart 10. Results of further surgery in patients living with disease after drainage alone.

statistics are better, however, than those of the last report from this clinic (King and Lord) which are based upon 96 patients operated upon. Of these 27, or 28.1 per cent, were cured, 38, or 39.5 per cent, died, and 31, or 32.3 per cent, remained alive with disease. This comparison is interesting. One notes a significant improvement in mortality, but as was pointed out before, the majority of operative deaths are due to the disease and are not attributable to the operation. It should be pointed out here, however, that the previous series was not carefully analyzed with this point in mind. The method of drainage used then was usually a one stage operation through a small incision, often with rather incomplete localization of the process, and insertion of a rubber tube or cigarette wick drain without any unroofing of the cavity as practiced now. As a result, it is quite possible that more of the deaths were definitely due to the operation. The actual operative mortality was estimated at that time to be in the neighborhood of 12.5 per cent (King and Lord). As described here, the operations used in the present series tended to be more radical and on the whole gave more complete drainage. The significant difference, however, is the marked improvement in the number of cures (from 28.1 to 43.5 per cent). This, we believe, is because in the present series the results of both primary lobectomy (5 cures) and secondary lobectomy (6 cures) come into play and were not a factor in the former group, and also because of the improvement in the technique of the drainage operation with more radical unroofing of the cavity.

In conclusion, a comparison of the results in each group is of interest (Table IV).

Here again one is forced to conclude that the improvement in results is because of the increased number of patients operated upon and the increased use of more radical measures including lobectomy in properly selected cases. One should note, however, that the percentage of spontaneous cures has remained essentially the same. Sufficient data are not available in reference to the earlier series to determine whether a more prompt resort to surgery was a factor in this improvement, but there was probably very little difference.

CONCLUSIONS

By this study certain facts which may be used further to improve our results in this serious disease seem apparent. It is suggested that they be utilized with this in mind, and the following suggestions are offered:

- 1 Patients should not be allowed to go without operation longer than 4 months from the onset of disease.

- 2 Patients with abscesses which do not show definite regression should be operated upon early—within 6 to 8 weeks after onset, often as soon as they are seen and the diagnosis confirmed.

- 3 The interval between stages of the two stage operation should in general not exceed 4 to 5 days, in the desperately sick patients, not more than 24 to 48 hours.

- 4 Certain cases, notably the upper lobe abscesses which are not too acute, should be subjected to primary lobectomy in preference to drainage.

- 5 Certain cases should be drained as a preliminary procedure with the idea of performing a lobectomy at a later time.

- 6 The operation of re-drainage should be abandoned. Patients who remain unhealed after primary drainage will do better if treated by lobectomy. (Note: The opening of secondary cavities not reached at first operation is not classified as re-drainage.)

- 7 All patients with lung abscess should have the benefit of the combined judgment of the internist, the bronchoscopist, the thoracic surgeon, and the roentgenologist, if the best results are to be obtained.

Given ideal conditions for the proper study and treatment of these patients, much better results can now be obtained than formerly but there still remains a large group of patients who will die of the disease. If further improvements are to be made in our results, they will probably emerge from a better understanding of the bacteriology and the related problems of immunology in these cases.

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ACUTE CHOLECYSTITIS

A Review of 320 Cases

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IT is not surprising that the treatment of acute cholecystitis lends itself to so much controversy and difference of opinion, for it is a condition, the recognition of which depends primarily on that most inexact of sciences—clinical impression. The diagnosis of acute cholecystitis has to be made without the aid of the newer diagnostic methods which are so useful in the recognition of chronic cholecystitis. Thus, in the final analysis the management of a case must rest on the clinical judgment of the observer—a factor obviously subject to great variation.

In an endeavor therefore to establish certain basic facts, we have reviewed 320 of our own cases of acute cholecystitis which we present herewith. In general we have followed the practice of early operation introduced by the senior author (R. D. Mc.) over 20 years ago but the individual surgeon has been guided by his own surgical judgment. Only one arbitrary rule has been followed and that is the necessity for considering immediate operation when the relative proportion of polymorphonuclear leucocytes approaches 90 per cent or the total leucocyte count rises above 20,000 per cubic millimeter.

The selection of cases for study presented a problem, for in reviewing our records we soon found that there were three types of acute cholecystitis—clinical, surgical, and pathological. The first two diagnoses are based on impression only while the pathological diagnosis is based on facts. Therefore the cases falling into the first two groups were discarded, and only those cases on which a pathological diagnosis of acute cholecystitis had been made were studied.

The criterion for diagnosis of acute cholecystitis as established in our pathological

department by Dr. Frank Hartman is microscopical evidence of polymorphonuclear infiltration of the gall bladder wall. This excluded from our review many cases in which diagnosis of acute cholecystitis had been made by both the clinician and the operating surgeon. However, because the results of immediate operation in this special group are so uniformly good, we were of the opinion, rightly or wrongly that their inclusion in a statistical study of acute cholecystitis was not justified because they were not truly examples of the condition. If these cases of simple edema of the gall bladder which accompanies gall stone colic had been included, our results would have been materially affected and a brief for rather than against, immediate operation would have been presented.

Sex. Acute cholecystitis, like chronic cholecystitis, is more common in the female than in the male, in the proportion of 2:1 a figure that is almost the exact reverse of the ratio obtained in our cases of acute appendicitis (7). Men, however, seem to be more prone to acute cholecystitis than women, for males comprise 30 per cent of our cases of acute cholecystitis as contrasted with 20 per cent of our cases of chronic cholecystitis.

Age. Acute cholecystitis is a disease of middle life, for 76 per cent of our patients were between the ages of 30 and 59. This again is in contrast to our statistics for acute appendicitis which showed that only 50 per cent of our patients were over 30 years of age (7). The age of the patients had a very definite bearing on mortality for of the 108 patients under 40 years of age there was only 1 death—a mortality rate of 0.9 per cent while in the group of 48 patients over 60 years of age there were 5 deaths, a mortality rate of 10.5 per cent. In the middle aged group of 64 patients between the ages of 40 and 60 there were

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deaths a mortality rate of 6.7 per cent. This shows very clearly that the death rate from cholecystectomy for acute cholecystitis rises with each succeeding decade.

Obesity. The overweight patients of this series numbered 163, or 50.9 per cent. Obesity in itself apparently had very little effect on the mortality, for of the 17 deaths, only 9, or 52.9 per cent, were overweight.

PRE-OPERATIVE HISTORY

Forty, or 12.5 per cent, of the patients had no previous warnings of gall-bladder disease. The others had suffered one or more attacks, usually over a period of years.

Two hundred and seventy-eight, or 86.8 per cent, patients had been treated medically and 9, or 2.8 per cent, had undergone cholecystectomy.

Nausea and vomiting were the most constant symptoms of acute cholecystitis, appearing in 91.2 per cent and 83.4 per cent, respectively, of the cases. Clinical jaundice was present in one-fourth of the patients and one-fifth of them complained of chills at the onset of the disease. Pruritus was a distressing symptom in 2.2 per cent of the cases, and further evidence of interference with biliary function was shown by the finding of highly colored urine in 12.8 per cent and of clay-colored stools in 8.7 per cent of the patients.

Pain and tenderness was present in either the right upper quadrant or the epigastrium in 90 per cent of the patients. A mass was palpated in one-fifth of the examinations. Most of these masses were found to be due to greatly distended gall bladders, but in some instances the mass represented the gall bladder surrounded by protecting adhesions and in others it was evident that the examiners had palpated the projecting edge of the liver. Muscle spasm of varying degree was observed in 88.1 per cent but the degree of spasm was not a gauge of the severity of the infection.

The group of patients whose maximum pre-operative temperature was above 102 degrees F. showed a mortality rate of two and one-half times the mean death rate for the series. This observation may be of some prognostic value, for it was the only pre-operative finding that indicated in any manner the group of cases in

which there was a high operative mortality. This group, of course, represents the more seriously ill patients in whom the mortality might be expected to be higher, but the inference still remains that these patients should have careful, extended observation and preparation for the operation.

Roentgenological confirmation of the diagnosis was sought in 155 cases, 48.4 per cent, and positive findings resulted in 116, or 74.8 per cent, of these examinations. The positive results in three-fourths of the cases make the procedure well worth while, and it is withheld only in the very ill patients or those in whom a considerable degree of liver insufficiency is suspected.

Pulmonary complications increased the operative risk three times and cardiac complications doubled the risk.

In this series the cases have been divided into three groups depending upon the duration of symptoms prior to operation. Group I, designated as the "emergency group" includes those operated upon within 24 hours after onset of symptoms, group II, the "early group," includes those operated upon between 24 and 72 hours after onset, and group III, the "delayed group," those operated upon after the lapse of 3 or more days from onset. The divisions are a modification of the groupings used by Cave in his recent discussion of acute cholecystitis.

Study of Table I shows little difference in the percentage of deaths of groups I and II but comparison of groups I and II with III suggests that the optimum time of operation is after the third day of the onset of symptoms. The low rate of 3.4 per cent in group III compared with the rates of 8.3 per cent and 7.3 per cent in the earlier groups is due to the subsidence of the infection, the response of the body defenses, and the more thorough preparation of the patient for surgery.

The length of *pre-operative hospitalization* for observation and preparation is covered in Table II. This table is also divided into groups having 24 hours, 24 to 72 hours inclusive, or more than 72 hours of hospitalization. There is a favorable difference between the emergency group which, with less than 24 hours of preparation, had a mortality of 8.4 per cent

TABLE I.—DURATION OF ILLNESS AT TIME OF OPERATION

Groups	No. of patients	Percentage	No. of deaths	Percentage
0 to 24 hours—				
Emergency	43	5	4	8.4
24 to 72 hours—Early	96	30	7	7.3
More than 72 hours—				
Delayed	76	25	6	3.4
Totals	320	100	7	5.3

and the early and delayed groups which had 1 or more days' hospitalization prior to operation. Comparison of group III with I and II reveals a rate of 3.1 per cent contrasted with rates of 5.2 per cent and 8.4 per cent. Again the implication appears that a delay until more than 3 days after onset and hospitalization reduced the hazard of operation, however the figures do not compare the degrees of sickness of the patients. It must be acknowledged that the more seriously ill patients had surgical treatment early, that is, as soon as they could be fortified against the shock of the operation by rest, sedation and fluids. Since more of the very ill patients had cholecystectomy before 3 days of hospitalization than after 3 or more days of preparation, the moderately higher death rate in groups I and II is partly explained. It must be conceded, however, that hospitalization for observation and preparation is a valuable procedure and that the emergency operation is the most dangerous.

Pre-operative diagnosis. The diagnosis of cholecystitis was made prior to operation in 96.3 per cent of the cases. The greater number of these were thought to be acute, but in a few instances the acuteness of inflammation was not recognized before exposure of the gall bladder at operation. Among the diagnostic errors, pancreatitis and perforated ulcer each appeared twice and appendicitis on four occasions.

The difficulty of correlating the clinical surgical and pathological diagnosis is emphasized by noting that in 35 of the 320 cases, or in 10.9 per cent, the operating surgeon made a diagnosis of chronic cholecystitis, while the specimen on pathological examination revealed evidence of acute cholecystitis. No doubt many of these erroneous diagnoses of chronic cholecystitis were made because the

TABLE II.—PRE-OPERATIVE HOSPITALIZATION

Groups	No. of patients	Percentage	No. of deaths	Percentage
Less than 24 hours—				
Emergency	7	2	8	8.3
24 to 72 hours—Early	54	43	8	5
More than 72 hours—				
Delayed	95	39.8	2	2
Totals	320	100	7	5.3

patient had had a clinical diagnosis of chronic cholecystitis. In general, however, the tendency was to overrate the severity of the condition found at operation. For example in 66 instances the surgeon recorded a diagnosis of gangrenous gall bladder while the pathologist recognized only 39 cases of gangrene, and similarly there were 40 surgical diagnoses of empyema of the gall bladder of which only 15 were proved pathologically.

OPERATIVE PROCEDURES

Cholecystectomy versus cholecystostomy. The gall bladder was removed in all of the cases in this series. Cholecystostomy is a rare operation at the Henry Ford Hospital.

Appendectomy. The close association of appendicitis and cholecystitis, both acute and chronic, is well recognized and has been frequently commented upon in the literature. The tendency and the teaching in general has been to advise against the removal of the appendix at the same time cholecystectomy is performed for acute cholecystitis. However, in our series, the removal of the appendix did not add to the mortality since 39.0 per cent of the patients had appendectomy performed in addition to removal of their gall bladder with a mortality rate of 2.4 per cent.

Common duct drainage. Edema of the structures usually obscures the common duct and makes its identification difficult. The usual teaching therefore is against choledochotomy. However in the presence of a common duct stone opening the duct becomes imperative. The mortality rate in our cases was not adversely affected when the common duct was opened and drained.

ASSOCIATED CONDITIONS

Gall stones. Gall stones were present in all but 29, or 9.1 per cent, of the 320 patients. The gall stones were located in the gall bladder in

87.7 per cent of the cases, in the cystic duct alone in 2.5 per cent, and in the common duct alone in 1.2 per cent. Gall stones were found in the common duct 20 times, i.e. in 6.2 per cent of the cases, though it is probable that their presence was sometimes overlooked owing to the difficulty of palpation occasioned by the edema of the structures. The rôle of calculus obturation of the cystic duct in the etiology of acute cholecystitis is emphasized by the finding of gall stones in 71 of the cases of 22.2 per cent of the series.

Pancreatitis The close association of cholecystitis and pancreatitis has long been recognized. In this series, pancreatitis was observed 18 times, or in 5.7 per cent of the cases. The involvement was acute in 2 instances, subacute on one occasion and consisted of thickening of the organ only in the 15 remaining cases. The infrequency of acute involvement of the pancreas in acute cholecystitis as we have commented upon elsewhere (3) suggests that infection plays a minor rôle in acute pancreatitis and appears to substantiate the chemical origin of the disease.

GALL-BLADDER CULTURES

Bacillus coli appearing in 25.7 per cent of the cultures, headed the list as the commonest organism cultivated. Growth of staphylococci and of streptococci each accounted for 11.5 per cent of the positive culture and *Bacillus lactis aerogenes* and *Bacillus coli* mixed with other organisms were obtained in four occasions each. *Bacillus typhosus*, *Bacillus dysenterica*, *Bacillus influenzae*, and yeast cells each appeared once. Negative culture obtaining in nearly one-half of the gall bladders cultured indicates that obstruction and chemical agents are factors in many cases of acute cholecystitis.

PATHOLOGICAL DIAGNOSIS

A diagnosis of chronic cholecystitis with acute exacerbation was made on 43.7 per cent of the patients. A previous attack of cholecystitis or long standing gall-bladder disease appears to confer some degree of immunity, for the lowest operative death rate, 3.6 per cent, was found in the group of patients whose acute cholecystitis was superimposed upon pre-existing cholecyctic disease. Further evi-

TABLE III — MAXIMUM POSTOPERATIVE TEMPERATURE

Temperature range F	No of patients	Percentage	No of deaths	Percentage
98.8-100.8	85	26.6	0	0.0
101-102.8	185	57.8	3	1.6
103-108	50	15.6	14	28.0
Totals	320	100.0	17	5.3

dence on this point is introduced by noting that the death rate in approximately the same number of patients with primary acute cholecystitis was 6.1 per cent or almost double that of the rate of those whose gall bladder had been infected previously.

Gangrene of the gall bladder was the most serious condition from the standpoint of mortality, for it showed a death rate of 10.4 per cent, almost double the rate of 5.3 per cent given by the series as a whole.

Empyema of the gall bladder occurred in only 5.9 per cent of the cases. There was only 1 death in this group, so that the mortality rate was 5.3 per cent or exactly the same as the mean for the entire series.

POSTOPERATIVE COURSE AND COMPLICATIONS

The majority of patients had relatively stormy postoperative courses. The difference between the reaction of these patients and of those recovering from cholecystectomy for chronic cholecystitis is striking. A general indication of the postoperative course is given by noting that 67 per cent of the patients required repeated administrations of intravenous glucose to maintain the glycogen content of the liver and 10.6 per cent required blood transfusions.

Some idea of the relatively sharp febrile reaction which occurs following removal of an acutely inflamed gall bladder may be obtained from a consideration of Table III. The cases are divided into three groups. Group I includes the 26.6 per cent of patients whose postoperative reactions were mild as indicated by the postoperative temperature, not rising to 101 degrees F. There were no deaths in this group. Group II is made up of the 57.8 per cent of patients whose postoperative reactions were moderately severe as shown by a temperature range of from 101 degrees F to 102.8 degrees F. There were 3 deaths in the group, a mortality of 1.6 per cent. Consider-

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Groups	No. of patients	Percentage	No. of deaths	Percentage
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Emergency	43	5	4	8.4
24 to 72 hours—Early	96	30	7	7.3
More than 72 hours—				
Delayed.	76	55	6	7.4
Totals	310	100	7	5.3

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The difficulty of correlating the clinical surgical and pathological diagnosis is emphasized by noting that in 35 of the 310 cases, or in 10.9 per cent, the operating surgeon made a diagnosis of chronic cholecystitis, while the specimen on pathological examination revealed evidence of acute cholecystitis. No doubt many of these erroneous diagnoses of chronic cholecystitis were made because the

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Groups	No. of patients	Percentage	No. of deaths	Percentage
Less than 24 hours—				
Emergency	71		6	8.3
24 to 72 hours—Early	54	43	8	5
More than 72 hours—				
Delayed	95	29.8	2	2
Totals	310	100	7	5.3

patient had had a clinical diagnosis of chronic cholecystitis. In general, however, the tendency was to overrate the severity of the condition found at operation. For example, in 66 instances the surgeon recorded a diagnosis of gangrenous gall bladder while the pathologist recognized only 19 cases of gangrene, and similarly there were 40 surgical diagnoses of empyema of the gall bladder of which only 15 were proved pathologically.

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ing groups I and II together i.e. those patients whose temperature did not reach 103 degrees F we find only 3 deaths in 270 patients, a mortality of 1.1 per cent. Group III consisted of the 25.6 per cent of patients whose postoperative reactions were severe as evidenced by postoperative temperatures which ranged from 103 to 108.8 degrees F. There were 14 deaths in the group of 50 patients giving a mortality rate of 28 per cent.

A fever of 103 degrees F or over after an operation for the removal of an acutely inflamed gall bladder indicates a serious condition of the patient, and should be considered as being of grave prognostic significance. All 4 patients whose temperature went to 107 degrees F or over died. In 2 the cause of death was given as peritonitis and in the 2 others, the fatality was listed as "liver death" (5).

Pulmonary complications, the commonest of postoperative complications in most series of cases presented (6) took second place in our series. A total of 30 patients, or 9.4 per cent of the series, were affected as follows: bronchitis 9, bronchopneumonia, 6, pulmonary collapse, 5, asthma, 3, lobar pneumonia, 2, infections, 2, lung abscess, 1 and 2 patients had reaction of latent pulmonary tuberculosis. There were 4 deaths, all from pneumonia, a mortality rate of 13.3 per cent.

We desire to stress the value of carbon dioxide inhalations in the immediate postoperative period and the use of the oxygen tent when the respiratory rate rises above 30 per minute in the prevention and treatment of pulmonary complications.

Myocardial weakness was encountered in 15 patients in 4.7 per cent of the series. The diagnosis was myocarditis on 10 occasions, auricular fibrillation 3 times and auricular flutter twice. Two deaths were from myocardial failure a mortality rate of 13.3 per cent.

Bleeding from the wound or deeper structures was not of common occurrence being noted in only 11 patients, or 3.5 per cent of the series. Hemorrhage was slight in 8 instances, moderate on 2 occasions, and severe enough to be fatal in 1 patient.

Peritonitis is a relatively infrequent complication of cholecystectomy for acute chole-

cystitis. It was seen in only 2.2 per cent of our cases and of the 7 examples, 2 died, giving a mortality rate of 28.6 per cent. The ability of the peritoneum to handle the gall bladder contents is emphasized by noting that there were only 2 deaths in the 22 patients in whom the gall bladder perforated before operation and in 1 of these the cause of death was given as myocarditis. This gives a mortality rate of 9.1 per cent in perforation of the gall bladder with subsequent operation. The peritoneal fluid was cultured at operation in only 18 instances, of which 5 or 27.8 per cent, were negative. Positive cultures for staphylococcus were obtained on 5 occasions. *Bacillus coli* on 4, streptococcus on 3 and *Bacillus typhosus* on 1.

Phlebitis, a disabling, though not dangerous complication was noted 6 times, or in 1.9 per cent, of the patients. There were no deaths. In the prevention of this complication we follow the teaching of Poole and insist upon our patients exercising in bed. Early and repeated movements of the arms and legs plus deep breathing and frequent changing of position improves the circulation in the iliac veins and must be a definite factor in lowering the incidence of thrombus formation.

Wound separation, a serious postoperative complication occurred 4 times, or in 1.3 per cent of our cases. There was 1 death following an ill advised attempt at secondary suture of the wound carried out before a study of our records impressed upon us the hazard of such a procedure (7).

Because of the proximity of the gall bladder to the subphrenic space and because of the frequency of extension of inflammation outside the gall bladder wall, one might expect a subphrenic abscess to be of frequent occurrence. However it was found in only 1 of our cases and the patient recovered after surgical drainage.

Pulmonary embolism, the most fatal of all complications, appeared twice and showed a 100.0 per cent mortality. This complication often considered as a pulmonary complication rightfully belongs with phlebitis, but since it is a preclinical phlebitis the conditions are described separately. The recent work on heparin (8) is interesting in this connection.

It may be that the absorption of liver products resulting from incidental damage to the liver parenchyma during cholecystectomy for acute cholecystitis may be a factor in preventing the more frequent occurrence of this dangerous complication

The usual period of hospitalization after operation for chronic cholecystitis at the Henry Ford Hospital is 17 days and yet only 14.2 per cent of patients were able to leave the hospital on the seventeenth postoperative day after cholecystectomy for acute cholecystitis. Furthermore, only 45.9 per cent of the patients were discharged from the hospital by the twenty-first postoperative day, and 20.9 per cent had their hospital stay prolonged beyond thirty days

MORTALITY

There were 17 deaths in the 320 patients subjected to cholecystectomy for acute cholecystitis, or a mortality rate of 5.3 per cent. The deaths resulting from cardiac and pulmonary complications, peritonitis, hemorrhage, and shock, have already been considered. Three of the fatalities occurred from overlooking other pathological conditions present which, at the time of operation were unrecognized, and were revealed only at postmortem examination. In 1 case an appendix abscess was the focal point of a fatal pyelophlebitis and in 2 cases concomitant perforated ulcer was responsible for the fatal issue. In all 3 patients the gall bladder showed definite evidence of acute inflammation and was accepted by the surgeon as being responsible for the clinical course prior to operation. This association of acute cholecystitis and perforated peptic ulcer we have found in 2 other cases, both of which recovered after the ulcer was dealt with. In one the condition was recognized at operation and in the other, operation was performed 3 days after cholecystectomy.

Two of the 17 deaths occurred in patients whose postoperative clinical course were characterized by hyperpyrexia, coma, and death. The cause of death in these cases was considered to be due to hepatic insufficiency on the so-called "liver death" of Heyd.

Fatal cases do not long survive the operative interference, for 82.3 per cent of the 17 deaths

had taken place by the fifth postoperative day. This finding suggests that liver insufficiency may be a factor in many of the fatal cases as well as those definitely attributed to "liver death."

FOLLOW-UP

The length of time most of the patients were under observation following discharge from the hospital is inadequate for establishing any data of definite statistical value for only 50.3 per cent of the patients were followed over 6 months. Five deaths occurred during the period of observation, 2 from pulmonary tuberculosis alleged to have been activated by the operation, 1 from myocarditis, 1 from lung abscess and 1 from carcinoma of the head of the pancreas.

A total of 42 patients, or 15.1 per cent of the 278 patients who were observed, returned for treatment. Of these, one half complained of the same symptoms as were present before operation. All were relieved by medical treatment. A total of 19 patients, or 45.2 per cent of those who returned, had symptoms suggestive of common duct stone. Of these, 14 had relief of symptoms from medical measures, and 5 were subjected to choledochotomy. Stones were removed in 3 instances, and on 2 occasions, the common duct exploration was unfruitful but the patient improved after T-tube drainage. Two patients were operated upon for common duct stricture with satisfactory results, but the surgeon may have been over-optimistic in not attributing the condition to operative traumas.

SUMMARY

1. The mortality in 320 consecutive operations for acute cholecystitis which were performed at the Henry Ford Hospital was 5.3 per cent.

2. The maximum pre-operative temperature is of some prognostic value for the death rate on patients whose pre-operative temperature was above 102 degrees F. was three times that of those whose temperature remained below 102 degrees F.

3. Pre-operative pulmonary disease increased the risk of operation three times, and cardiac disease doubled the operative risk.

4. The lowest mortality rate was obtained in patients whose operation was delayed for at least 72 hours from the symptoms.

5. The highest mortality rate obtained in the gangrenous cases.

6. Gall stones were present in 90.9 per cent of the cases.

7. A postoperative temperature of above 103 degrees F indicates a serious condition of the patient and is of considerable prognostic value for the mortality among the group of patients whose postoperative temperature rose above 103 degrees F was 28 per cent.

8. The seriousness of acute cholecystitis is emphasized by the fact that less than 15 per cent of patients were discharged by the seventh postoperative day and over 20 per cent remained in the hospital longer than 30 days.

9. The short duration of life in the fatal cases, over 80 per cent of the deaths occurred before the fifth postoperative day suggests that hepatic insufficiency might be a factor in the mortality.

CONCLUSIONS

Removal of the gall bladder during an attack of acute cholecystitis gives good results and the mortality is within reasonable limits. From this study of our cases, we are forced to the conclusion that the best results in acute cholecystitis are obtained by deferring operation until at least 72 hours have elapsed since the onset of the disease. These results will be further enhanced by an adequate period of pre-operative hospitalization. Our results improved with each succeeding 24 hours of preparation, reaching their maximum after 72 hours.

It is probable that immediate or early operation can be practiced with a low mortality in approximately 85 per cent of patients with acute cholecystitis, but in the remaining 5 per cent the mortality rate will be prohibitively

high. At the present time there is no known method of recognizing the latter group other than by clinical judgment. Therefore until the time arrives when these patients can be diagnosed and excluded, it would appear better to delay operation in the whole group until the fluid balance is restored the glycogen content of the liver is augmented and an estimate of liver function is made. Cases of impending gangrene or perforation must be of course treated as any other surgical emergency.

We believe further that the value of liver function tests has not been appreciated fully and we are inclined to agree with Ivy that surgery should not be attempted on the biliary tract without the benefit of these tests. In acute cholecystitis it is probable that the routine use of those liver function tests, which are not harmful will lower the mortality rate by recognizing liver insufficiency and preventing untimely operations.

The authors wish to express their appreciation of the assistance given by Dr. Edward Casapelli in the compilation of this material.

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SCOLIOSIS

Its Experimental Production and Growth Correction, Growth and Fusion of Vertebral Bodies

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BY implication as well as fact, the term idiopathic scoliosis designates that group of structural, rotary, lateral curvatures of the spine of unknown or unestablished etiology. Upon the basis of the experimental data which follow and some pertinent clinical evidence to be discussed, it is proposed that inequality of growth on the 2 sides of vertebral bodies of a portion of the spine or, in other words, unilateral growth disturbances are either totally responsible or at least contributory in a large measure to the development and progression of this group of curvatures.

Two possible clinical applications of these experimental data are also proposed. These are (1) unilateral operative arrestment of growth of several vertebral bodies for purposes of gaining some correction of curvatures during the subsequent period of growth, and (2) the accomplishment of vertebral fixation by fusing vertebral bodies directly.

EXPERIMENTAL DATA

Kid goats were used for these studies because they are particularly rugged. Compared to other newborn animals they are remarkably tolerant of major surgical trauma and seldom acquire disease.

All kids were less than 4 weeks old when operated upon. The bodies of the lumbar vertebrae were approached retroperitoneally through an incision parallel to the lateral border of the erector spinae muscles from the twelfth rib to the level of the crest of the ilium and thence directed anteriorly for a short distance. The bodies were easily exposed by retracting the perireneal fat, kidney, and psoas muscle mesially and anteriorly. The lumbar

vessels which pass laterally at the center of the bodies were divided between ligatures and the common ligaments and periosteum split longitudinally, elevated, and retracted to expose the bone and epiphyseal cartilages.

The bodies of the dorsal vertebrae were approached extrapleurally through an incision which paralleled the lateral border of the erector spinae muscles from the ninth to the eleventh ribs and then followed the eleventh rib anteriorly to the posterior axillary line. The eleventh rib was resected from its neck to the posterior axillary line. Through the bed of this rib the endothoracic space was entered, and the parietal pleura was carefully separated from the thoracic wall and retracted anteriorly and mesially until the anterior surface of the vertebral bodies had been exposed. The intercostal vessels, which like the lumbar vessels course laterally over the surface of the bodies, were divided between ligatures. The exposure was completed by dividing the common ligaments and periosteum longitudinally and then retracting them.

With the vertebral bodies thus exposed either above or below the diaphragm, various operative procedures were carried out. In several animals both lumbar and thoracic vertebrae were operated upon but always in 2 stages.

The animals were killed 10 months later when they were 11 months of age, and the spines were removed for comparative studies.

1 Growth of vertebral bodies. Regarding the source of growth of vertebral bodies there exists much disagreement. There is the question of interstitial, longitudinal growth, and among those who believe that there is no interstitial growth, there is disagreement as regards the proportion of length gained from the epiphyseal cartilages at the 2 ends.

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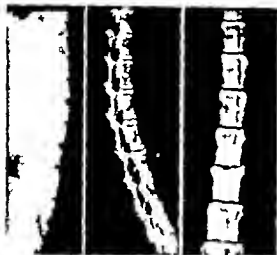


Fig. 1. Goat. Table I. Shot markers in the bodies of first, second, third, and fourth lumbar vertebrae, showing longitudinal growth during period of 10 months. The roentgenogram at the left was made immediately following operation; the goat was 3 weeks of age; the to the right, 10 months later. Note that the shots in the 3 proximal vertebrae retained their original positions equidistant from the ends. Growth was arrested from the proximal end of the distal fourth lumbar vertebra, and as result note failure of this end of the vertebra to move away from the shot. In other words, failure of growth. The resultant shortening of this vertebra and the absence of its proximal growth cartilage are apparent in both anteroposterior and lateral views.

As shown by the data which follow the vertebral bodies of goats gain length solely from the epiphyseal cartilages and the increments from both ends are equal.

In each of 4 kids approximately 2 weeks of age holes were drilled in several vertebral bodies midway between the ends and steel shots placed in the drill holes. Roentgenographic records were made both immediately following operation and 10 months later. At operation and at postmortem examination 10 months later direct measurements were made of the distances from each shot to the intervertebral discs immediately proximal and distal to it and of the distance between the shots themselves. These comparative measurements are listed in Table I.

In 2 goats the shots were placed in 4 contiguous vertebrae at their centers. The roentgenographic records of these animals are illustrated in Figures 1 and 2. It will be observed from both roentgenographic and

TABLE I.—DISTANCE FROM SHOT MARKER TO ENDS OF VERTEBRAL BODIES RECORDED IN MILLIMETERS

	L		L		L		L	
	P	D	P	D	P	D	P	D
Goat 11—Age 10 months	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2
Goat 12—Age 10 months	1.5	1.2			1.5	1.2	1.5	1.2
Goat 13—Age 10 months					1.5	1.2	1.5	1.2
Goat 14—Age 10 months					1.5	1.2	1.5	1.2

The units are indicated: P, proximal; D, distal; the vertebrae are L, or the first, second, third, and fourth lumbar.

*Growth arrested irregularly.
†Distances between shots in distal end and epiphyses.

actual measurements that the shots in the 3 proximal vertebrae retained their same relative positions in respect to the ends of the vertebral bodies. In other words, the increments from the 2 ends were equal.

In the distal vertebrae of each kid growth was arrested on the side operated upon in addition to placement of shot markers. Growth was arrested from only the proximal end in one and from both ends in the other. This arrestment of growth was accomplished by removing as much of the presenting epiphyseal or growth cartilage as possible. In the first animal no length was gained from the proximal or arrested end whereas a normal gain in length took place from the distal or undisturbed epiphyseal cartilage (Fig. 1). In the second animal there was no growth in length from either end on the side operated upon; the original length of the body on that side was maintained (Fig. 2) (Table I goats 11 and 12).

Somewhat more graphic confirmatory evidence that longitudinal growth is acquired from the epiphyseal cartilages only was supplied by observations in 2 additional goats. In each shots were placed in the bodies of 2 contiguous vertebrae and growth was arrested from the proximal end of the proximal one of these 2 marked vertebrae. A shot was then firmly wedged into the groove from which the cartilage had been removed and a second shot

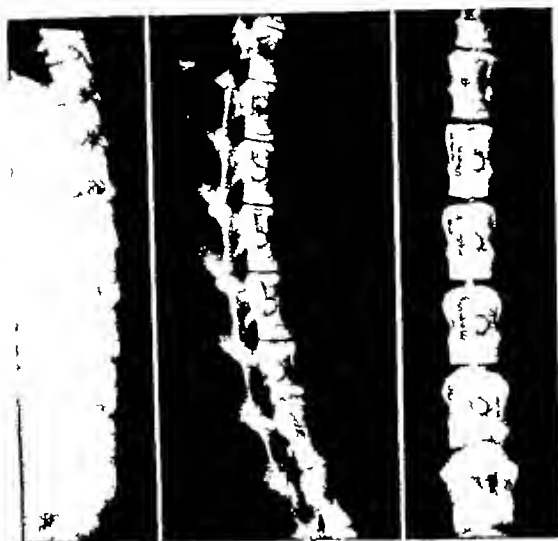


Fig 2 Goat 15, Table I Same as in Figure 1, except that growth was arrested surgically from both distal and proximal ends of the distal fourth lumbar vertebra. Note absence of growth cartilage at both ends and failure of growth as evidenced by shortening. Compare length with adjoining vertebrae.



Fig 3 Goat 3, Table I In addition to marking bodies of third and fourth lumbar vertebrae with shot, growth was arrested surgically from the proximal end of the third lumbar vertebra and shot markers placed in the proximal epiphysis of this vertebra and in the intervertebral disc between the 2 vertebrae. Note that during a growth period of 10 months, from 1 month old at the left to 11 months at the right, the distance between the upper 2 shots has remained relatively unchanged, showing failure of growth as a result of the operative arrestment. Also note absence of this epiphyseal cartilage. Growth took place from the distal end of this third lumbar vertebra as shown by the increase in the distance between the middle 2 shots. Likewise, the increase in the distance between the lower 2 shots demonstrates the gain in length from the proximal end of the fourth lumbar vertebra.

was placed in the intervertebral disc between the 2 marked vertebrae. In the proximal vertebra, as shown in Figure 3, the distance between the shot in the diaphysis and that in the epiphysis remained relatively unaltered during the 10 months' period of growth. Thus no growth was acquired from the end from which the growth cartilage had been removed. In contrast, the distance between the shot in the diaphysis and that in the intervertebral disc increased considerably. This evidence of growth was also observed in the distal vertebra. The actual measurements are recorded in Table I, goats 3 and 4. It will be noted that in each animal the total growth of the proximal vertebra was distinctly less than that of the distal vertebra.

wedge-shaped and distorted the spine into lateral deviation with the concavity of the curvature on the side where growth had been arrested. The lateral bending was accompanied by rotation. The curvatures in 2 goats are illustrated in the photographs and roentgenograms in Figures 4 and 5.

In 3 animals of this series an additional study was made. In addition to growth arrest fusion between contiguous vertebral bodies at another level of the spine was accomplished by placing grafts in contact with the exposed cancellous bone of these bodies. The grafts were laid along one side only, immediately anterior to the transverse processes and were so placed that they bridged the intervertebral discs and established bony continuity between the bodies. In 2 of the animals 4 contiguous

2 *Experimental scoliosis* In a series of 6 kid goats, segments of both distal and proximal growth cartilages were removed from one side of 2 or more vertebral bodies, 2 in 3, and of 3 in 3 animals. The cartilages were removed from those halves of the bodies exposed at operation. There resulted arrestment of growth on the side operated upon with continuance of growth on the opposite or undisturbed side. The vertebral bodies became

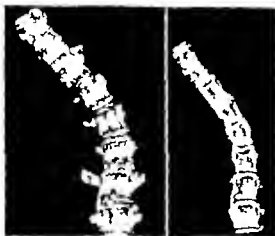


Fig. 4. Goat 5. Scoliosis in goat 7 months of age resulting from unilateral arrestment of growth of second, third, and fourth lumbar vertebrae. Growth was arrested by excising portion of the right half of both proximal and distal epiphyseal cartilages from these vertebrae 1 month of age. Note presence of rotation as well as lateral bending, also the wedge-shaped second, third, and fourth lumbar vertebrae and evidence in both photograph and roentgenogram of destruction of the epiphyseal cartilages of these bodies for depth of approximately one-fourth of their breadth on the side operated upon. An only graft consisting of segment of rib as placed in contact with exposed cancellous bone of the bodies of the fifth and sixth lumbar vertebrae. Note fusion of these vertebral bodies by bridge of bone and that this fusion has not disturbed the growth of these bodies.

vertebrae were fused (Fig. 5) and in 1 only 2 vertebrae (Fig. 4).

In addition to these 3 animals in which both growth arrest and fusion operations were carried out 1 goat was subjected to fusion operations only. These were carried out in 2 stages by fusing the tenth and eleventh thoracic vertebrae at the first operation, and the fourth and fifth lumbar vertebrae at the second operation (Fig. 6). To fuse the thoracic vertebrae a rib graft was used and to bridge the lumbar segments chip grafts were obtained from the vertebral bodies and from their transverse processes.

In every instance fusion by a firm, bony bridge resulted. Injury to the growth cartilages was carefully avoided. Consequently growth progressed normally despite the development of a large solid segment of bone extending between the vertebral bodies and across the growth cartilages (Figs. 4, 5 and 6). Thus fusion by a bony bridge did not

interfere with growth. Furthermore this bony bridge became elongated to accommodate itself to the longitudinal growth of the vertebrae. It is apparent therefore that under certain circumstances bone that is transplanted bone is capable of intrinsic growth in length.

Observation showed that these fusions directly between vertebral bodies were very firm and rigid and the operations were accomplished with comparative ease and without appreciable shock to the animals.

ANALYSIS OF STUDY

The first step in this investigation was the establishment of the fact that vertebrae grow in length solely from their epiphyseal growth cartilages. With this established it was reasoned that removal or destruction of these growth cartilages would prevent further growth in length of vertebrae so treated and that if the cartilages were destroyed on one side only unilateral growth arrest, wedge-shaped vertebral bodies, and lateral deviation of the spine would result. This is precisely what happened a structural rotary-lateral curvature was obtained.

It seems logical to assume that the vertebrae of man likewise grow in length solely from the epiphyseal growth cartilages and that unilateral retardation of growth would bend and twist the spine in similar fashion. However before progressing further with this discussion it is important to recognize the fact that in all comparative investigation of scoliosis in experimental animals one is confronted with the all important influence of posture and the inability in animals to simulate and therefore evaluate the influence of the erect posture assumed by man. We see no reason why this fact should in any way detract from the direct application of these experimental observations to comparable findings in man. Structural changes from arrested growth should take place irrespective of the position of the spine the spine which balances superincumbent weight in a vertical position should develop a curvature with less provocation, and it should bend more extensively and the curvature be more progressive under the same influence than the horizontal spine.

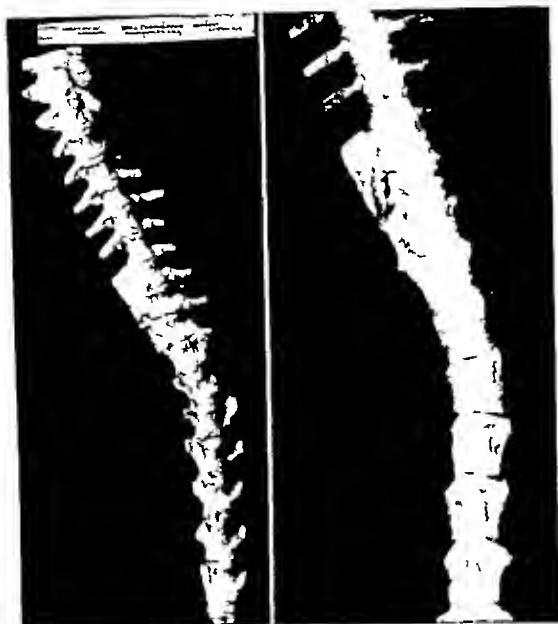


Fig 5 Spine of a goat 10 months after operative fusion and growth arrest performed before the animal was 1 month of age. Growth was arrested on the right side of first and second lumbar vertebrae through a subdiaphragmatic approach and 1 week later the bodies of ninth, tenth, eleventh, and twelfth thoracic vertebrae were exposed extrapleurally and fused by onlaying grafts of segments of 2 ribs. Note wedging of first and second lumbar vertebrae and the resultant scoliosis, also the firm fusion of the lower thoracic vertebrae and the failure of this fusion to disturb growth of these vertebral bodies.

The curvatures produced in these experimental animals have much in common with idiopathic scoliosis of man. It is our belief, therefore, that inequality of growth on the 2 sides of the vertebral bodies plays a major rôle in the production and progression of idiopathic scoliosis. If not the primary etiological factor, as it may well be, it is an important contributing factor. This contention is supported by the fact that these curvatures develop only in children and pre-adults, that is, during the period of active growth, and they cease to progress as soon as growth is terminated.

How otherwise can one explain the development of wedge-shaped vertebrae? The only other possible explanation is absorption of bone and compression of the vertebrae on one side. As the spine bends laterally, pressure exerted by the superincumbent weight is



Fig 6 Fusions 10 months after operation between the fourth and fifth lumbar and tenth and eleventh thoracic vertebral bodies accomplished in 2 stages. In the thoracic region costal grafts were used and in the lumbar region chips which were removed from the vertebral bodies and their transverse processes. Again fusion did not appreciably disturb growth of these bodies.

shifted and applied principally to the sides of the vertebrae on the side of concavity. Therefore, it may be reasoned that this pressure causes compression and narrowing of the vertebrae on that side. This type of compression is observed in conditions associated with extreme skeletal demineralization or with destruction of the vertebrae. But in the presence of normal mineral metabolism the response of bone to increased stress or pressure is quite the opposite. It responds by reinforcement in accordance with Wolff's law. If wedging does result from pressure absorption and compression, these structural changes should continue to increase after growth ceases and they should develop with curvature arising during adult life. In the scolioses which do arise during adult life, such as those resulting from thoracic disease and operations upon the thorax, the vertebrae develop little or no structural change.

It is more probable that abnormal pressure causes wedging by retarding growth rather than by compression. For example, it may be

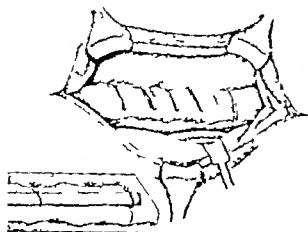


Fig. 7 Retroperitoneal operativ approach for exposure of the lumbar vertebral bodies through an incision along the lateral margin of the erector spinae muscles. The peritoneal fat, kidney, peritoneum and fibers of the psoas muscle are retracted medially and anteriorly. The old troublesome bleeding the lumbar vessels are divided between ligatures. By incising longitudinally and elevating the common ligaments and peritoneum, the bone or growth cartilages can be exposed readily. The method of arresting growth by excising portion of the epiphyseal cartilages is illustrated. The lower depicts the method of applying partially labial graft to accomplish direct fusion between vertebral bodies.

assumed that the curvature of idiopathic scoliosis is initiated by some factor such as muscle imbalance and that as the spine deviates laterally the abnormally increased pressure exerted on the sides of the vertebrae on the concave side of the curvature causes retardation of growth on that side. The consequent wedging of the vertebral bodies contributes to the progression of the curvature. Strong contradictory evidence to this hypothesis is presented by the findings in emphysema or pleurogenic scoliosis in children. As pointed out in a previous publication (1) the vertebrae in this type of scoliosis develop little or no structural change despite lateral bending and the vigorous compressing force of the contracting pleural scar. Not infrequently a curvature of this type is corrected completely following a Schede thoracoplasty which in addition to removing a portion of the thoracic wall, releases the pull of the pleural scar. Such readjustment of the vertebrae would be impossible in the presence of significant structural change in the vertebral bodies.

It is equally probable that unilateral retardation of growth is the initiating as well as the contributing factor. This is supported by the fact that the fixed structural type of curvature usually does not develop in children whose spines deviate laterally to accommodate for an inequality in the length of the lower extremities. As a rule curvatures of this type increase only as the inequality in the length of the legs increases and the spine im-

mediately straightens when this inequality is corrected and the pelvis made horizontal by raising the short leg.

In paralytic scoliosis of anterior poliomyelitis in children the vertebrae frequently become wedge-shaped. Unquestionably these structural changes result from unilateral retardation of growth and for the same reason that growth is retarded in paralytic extremities. Shortening in paralyzed extremities is attributed to disuse and to trophic influences. Both of these factors, we believe exert their influence through the vasomotor mechanism, so that the fundamental cause of the growth retardation is the diminution in the blood supply of the growth cartilage. Each lateral half of the vertebral body has an independent blood supply received from nutrient vessels which enter the body to the left and right of the midline. These nutrient vessels are branches of their respective left and right intercostals in the thoracic region and of the right and left lumbar vessels below the diaphragm. Thus from the standpoint of circulatory influence the vertebral bodies may be bisected into right and left halves and upon this basis unilateral growth retardation in these paralytic cases may be explained.

The curvatures of paralytic scoliosis are in constant in respect to the direction in which they deviate that is the convexity may be directed to the side with either the weaker or the stronger muscles. However when structural changes are present in the vertebrae the

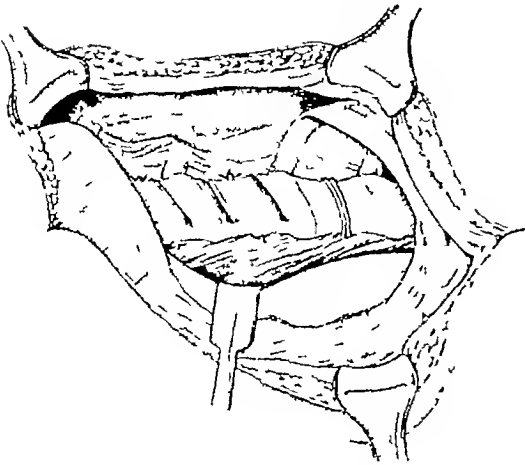


Fig 8 Extrapleural approach to the thoracic vertebral bodies. Short segments of 2 ribs are resected from the costovertebral articulations laterally. Through the rib beds the endothoracic space is carefully entered and the parietal pleura dissected from the thoracic wall and retracted mesially and anteriorly, thus exposing the vertebral bodies. The intercostal vessels are divided between ligatures and the common ligaments and periosteum incised longitudinally, elevated, and retracted. Illustrated is the method of arresting growth.

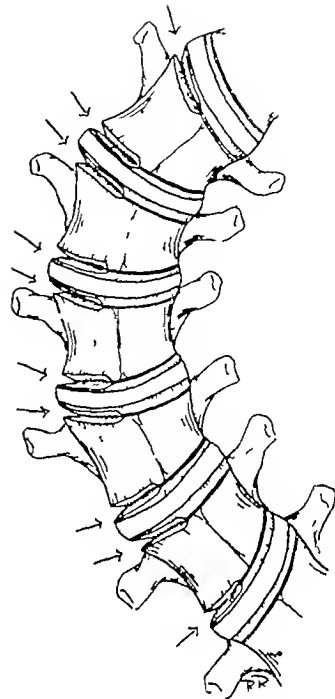


Fig 9 Diagrammatic illustration of a scoliotic spine in which segments of both distal and proximal growth cartilages have been excised on the side of convexity of 5 vertebræ at the apex of the curvature. The resultant growth arrest on the side of convexity should retard progression of the curvature, and if length is gained from growth on the opposite side of these vertebræ, some correction of the curvature should take place.

convexity will be found on the stronger side and the changes from retarded growth on the weaker or more completely paralyzed side.

If unilateral growth retardation is the sole factor responsible for idiopathic scoliosis, what causes this unilateral retardation of growth? Among the theoretically possible causes are epiphysitis or epiphyseodystrophy and congenital abnormality of the cartilage. The latter possibility is suggested by an observation made by Chandler, who has noted that children with idiopathic scoliosis frequently present maldevelopment of the mandible.

GROWTH CORRECTION OF SCOLIOSIS

From the above experimental evidence that growth on one side of vertebræ can be arrested by removal of portions of the epiphyseal growth cartilages on that side, the possibility of accomplishing correction of curvatures of idiopathic scoliosis in suitable cases by this means suggests itself. The type of case which would seem suitable for this proposed form of treatment would be a child who has a moderate curvature and several years in which to grow. With growth arrested on the side of

convexity in several vertebræ at or near the apex of the curvature, any increase in length on the side of concavity should bring about some correction of the curvature.

As to the accessibility of the vertebral bodies in man, I may state that in performing the operations of Peet and of Craig for essential hypertension we have always exposed several vertebral bodies both above and below the diaphragm, and this has been accomplished without technical difficulty or appreciable shock to the patients.

In patients with scoliosis, exposure of vertebral bodies should be accomplished more easily, because on the side of the convexity the ribs are abnormally widely separated and the vertebral bodies are near the surface. With the resection of segments of 2 ribs it should be possible to expose 6 or more of the vertebral bodies.

goats the centers of ossification for the epiphyses appear early, there were well formed epiphyses at the time of operation, which was only as 2 weeks after birth. In man these epiphyses appear at about the seventeenth year of age with the diaphysis during the twenty-second year of life. Thus to accomplish growth correction of scoliosis in children would be necessary to excise the full thickness of the cartilage from the diaphysis to the vertebral disc on one side.

FUSION OF VERTEBRAL BODIES

Under certain limited circumstances it seems feasible to apply the method of fusion of vertebral bodies clinically by means of onlay grafts as demonstrated in the animal studies here discussed. It would be applicable only in those cases in which there is no vertebral infection and in which it is necessary to fuse not more than 4 vertebrae. Among such possible indications are old compression fractures and high myelomata—above the fifth lumbar ver-

CONCLUSIONS

In goats and presumably in man, all growth in the length of vertebrae is derived from the proximal and distal epiphyseal

growth cartilages. An equal increment is received from each cartilage.

2. Excision of the epiphyseal growth cartilages results in arrestment of growth in length. Unilateral excision causes unilateral growth arrest.

3. The production of rotary lateral curvatures of the spine in goats by unilateral growth arrest of 2 or 3 vertebrae is reported.

4. Both experimental and clinical observations are presented as evidence that unilateral retardation of growth of vertebrae is either totally or at least partially responsible for idiopathic scoliosis of man.

5. Fusion of vertebral bodies *per se* with no damage to the epiphyseal cartilages does not arrest growth.

6. Under the influence of a distracting force bone that is, grafted bone is capable of intrinsic growth in length.

7. Methods for growth correction of scoliosis and for direct fusion of vertebral bodies are proposed.

Since this paper was received for publication there has appeared a report of similar experimental studies by S. L. Haas, *J. Bone & Joint Surg.*, 9:66, 1927. In general the results agree with those of Haas.

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CANCER OF THE THYROID

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CANCER of the thyroid is an exceptional disease in that it fails to follow the general tumor behavior laws, and its reaction to surgical and radiation therapy is quite unique. Even though a wealth of operative material has been studied histologically, there is no tumor in the head and neck group which seems to present more diagnostic problems for the tumor pathologist. All tumor gradations from benignity to malignancy are noted in addition to the six histologically definite cancer groups used in this report.

In order that the resulting statistics and conclusions may have some factual value, we have excluded from consideration all records in which microscopic evidence of true thyroid cancer is lacking. In most of the early cases biopsies were not done, as it was considered a dangerous procedure. Not until 1928 was any very consistent effort made in each case to confirm the clinical diagnosis by histological study, so that although 973 patients with tumors of thyroid origin have been admitted to Memorial Hospital, and at least 248 of these were clinically cancerous, in only 167 instances do we have histological evidence as to the cellular type of the cancer and its histological grade. This series of thyroid cancers comprises 0.43 per cent of the general admissions to our institution.

MATERIAL

Fifty per cent of our patients had received pre-admission surgical treatment (83 of 167—Table I). An additional 5 per cent had received medical treatment, and only 25 per cent (42 of 167) received their primary therapy at Memorial Hospital. Many cases hopelessly advanced were sent to us for any possible palliative radiation therapy (Fig. 1). All patients hopeless or otherwise were accepted

for treatment if they were ambulatory, and if bedridden they were accepted up to the bed capacity of the hospital. Obviously, it will be more difficult to demonstrate satisfactory end-results with this material than with the straight surgical series in which 60 per cent of the thyroid cancers are so small and well encapsulated as not to be suspected before thyroidectomy (Pemberton). In other words, the easily curable cases are unsuspectingly cured by routine surgical procedures in the average surgical clinic. To summarize the material admitted to Memorial Hospital, we find that 50 per cent of the patients had received previous surgical attention, 70 per cent were considered as inoperable, 37 per cent presented evidence of metastatic thyroid cancer, and 44 per cent showed evidence of obstruction to the upper food or air passageways (Table II).

Cancer of the thyroid occurs more frequently in females, the proportion in this series being 117 females to 50 males, roughly 2 to 1 (Fig. 2). The majority of cases occur in the age groups of 40 to 60. The youngest patient was a boy of 9 years of age and the oldest a female of 86 who had a bulky cancer of lingual thyroid origin. She is now alive and well at the age of 91 (Fig. 3).

Regardless of our large metropolitan negro and oriental population, only 4 patients in this series were negroes and only 1 came from the Orient. As to foreign birthplace, Russians, Germans, and Italians predominated in that order (Table III).

The primary tumor was confined to one lobe of thyroid gland in 87 cases (48 right lobe and 39 left lobe). The isthmus alone was involved 8 times and the growth involved both lobes in 50 cases, with substernal extension of disease being noted 18 times (Table IV). In several cases presenting extensive unilateral or bilateral cervical chains of thyroid cancer, we suspected the process of having developed from multiple sites in aberrant thyroid rests, but as small, unsuspected, pri-

From the Head and Neck Department, Memorial Hospital, service of Dr. Hayes E. Martin.

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Fig. Advanced cancer of thyroid (small alveolar adenocarcinoma). Infrared photograph to show dilated venous plexuses resulting from tumor obstruction of the internal jugular veins. An inoperable case accepted for palliative radium pack therapy.

mary foci of cancer were found in the thyroid gland itself at operation, our original contention had to be withdrawn and in only one questionable case is an aberrant nature of the primary disease suspected. In 3 instances pri-

TABLE I.—PREVIOUS TREATMENT

	No. cases
Surgical	55
X-ray therapy	5
Surgery and X-ray therapy	9
Surgery and radium	5
Biopsy	3
Tracheotomy	
Eradication	
Medical (iodine, thyroid extract, ice packs, etc.)	8
N. treatment	4
Not stated	23
	67

Nearly 75 per cent of the cases of thyroid cancer admitted to Memorial Hospital have had previous treatment. Fifty per cent had subsequent surgical treatment elsewhere.

mary cancer developed in lingual thyroid tissue.

ETIOLOGY

As to the etiology of cancer of the thyroid we find in our study nothing which definitely points to a specific cancerogenic agent.

HISTOLOGY

Recognizing the many histological variations of thyroid cancer, it has been our aim to classify these growths into as small a number of groups as possible and with this in mind Dr. F. W. Stewart has reviewed the pathological material used in this report and again points out the difficulty in differentiating between benign and malignant thyroid growths. For this reason all questionable cases were classed as benign. Somewhat arbitrarily we selected the following 6 major types of thyroid cancer, each of which presents its own more or less typical histological and clinical characteristics. This grouping is practically the same as that suggested by Haagensen.

First, and occurring most frequently—34 per cent of the cases—is the papillary adenocarcinoma (Fig. 4). This tumor is moderately radiosensitive, invades neighboring structures, and metastasizes frequently to the regional lymph nodes, but practically never to distant structures by way of the blood stream. Histologically the tumor presents a network of branching papillae projecting into cystic cavities which may contain a gelatinous substance. The papillae are lined with a single or multiple layer of cuboidal or cylindrical epithelial cells.

In the second group are the small alveolar large cell adenocarcinomas which make up 27 per cent of the series (Fig. 5). The structural feature common to this group is the alveolar arrangement of compact masses or cords of

TABLE II.—FIRST SYMPTOM—167 CASES

	No. cases
Lump in thyroid (goiter)	60
Lump in neck (cervical metastasis)	38
Bone pain, dysphagia, dyspnea, etc. (distant metastases)	5
Not stated	4

First symptom was due to metastases in 10 cases (27%) of this series.

Primary cancer of the thyroid gland may be quiescent for years and in one-third of our cases the patient's first symptom, as produced by metastatic deposits of the disease,

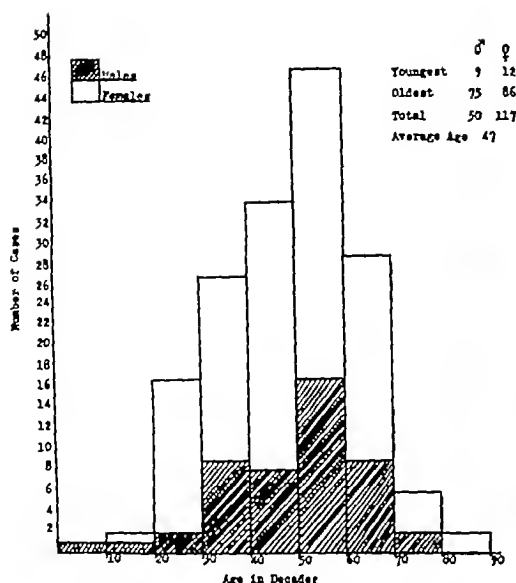


Fig 2 Thyroid cancer occurs in females twice as frequently as in males. The largest group of patients were between 50 and 60 years of age.

cells. Adult alveoli containing colloid are seen and the cell cytoplasm is slight in amount, opaque, and granular, and stains heavily with

TABLE III — RACE AND BIRTHPLACE IN A SERIES OF 167 CASES

Race	
Caucasian	161
Negro	4
Oriental	1
Not stated	1
	167
Birthplace	
United States	67
Russia	38
Italy	14
Germany	8
Austria	8
Ireland	7
Poland	4
Roumania	3
Hungary	3
France	2
British West Indies	1
Honolulu	1
Turkey	1
Canada	1
Spain	1
Czechoslovakia	1
Not stated	7
	167

Our patients were largely of the white race. Only 4 negroes and 1 oriental have received treatment for thyroid cancer at Memorial Hospital.



Fig 3 M Y. Showing a large bulky thyroid cancer having its origin from embryonic thyroid tissue at the base of the tongue. Patient 86 years of age, now alive and well at age of 91.

eosin. These growths are only slightly radio-sensitive, they grow rather rapidly, reaching a huge size and soon cause dysphagia and dyspnea. They metastasize regularly through blood and lymph channels.

Spindle and giant cell adenocarcinomas have been placed in the third group. They comprise 13 per cent of the series (Fig 6). These neoplasms are extremely malignant, quite radioresistant, metastasize widely to cervical nodes and distant areas, and are rapidly fatal. The histological picture is that of irregularly growing sheets or strands of very anaplastic, hyper-

TABLE IV — LOCATION OF PRIMARY TUMOR — 167 CASES

	No. cases
Right lobe	48
Left lobe	39
Bilateral	50
Isthmus	8
Lingual	3
Aberrant (?)	1
Pyramidal lobe	1
Not stated	17

Substernal extension of disease was noted in 18 cases.

Thyroid cancer shows a definite tendency to involve both lobes of the gland. Adenocarcinoma having its origin in aberrant thyroid tissue occurred only once.

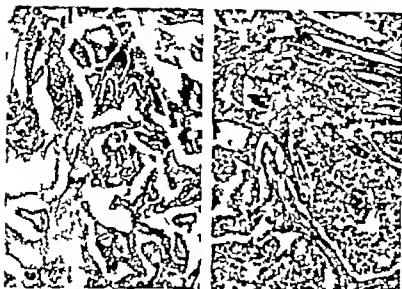


Fig. 4. Papillary adenocarcinoma, grade 1. This type of cancer occurred in 34 per cent of our cases.



Fig. 5. Small atypical and solid adenocarcinoma, grade 2, with vascular invasion. This type of cancer occurred in 27 per cent of our cases.

chromatic cells varying greatly in size and shape. The largest cells are somewhat fusiform in shape and these form the so called giant cells.

The fourth group comprises those cases designated as small round cell carcinomas (Fig 7). Five per cent of the series was so classified. These tumors are most malignant. Death

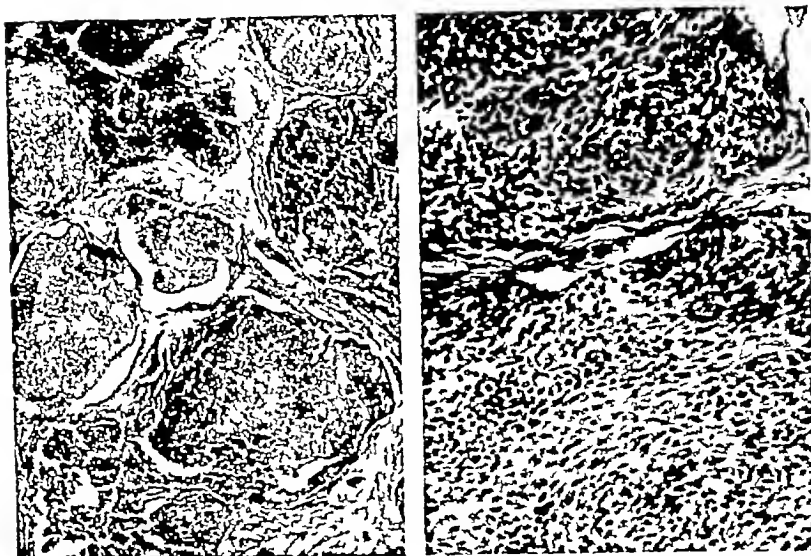


Fig 6 Spindle cell and giant cell adenocarcinomas made up 13 per cent of the series

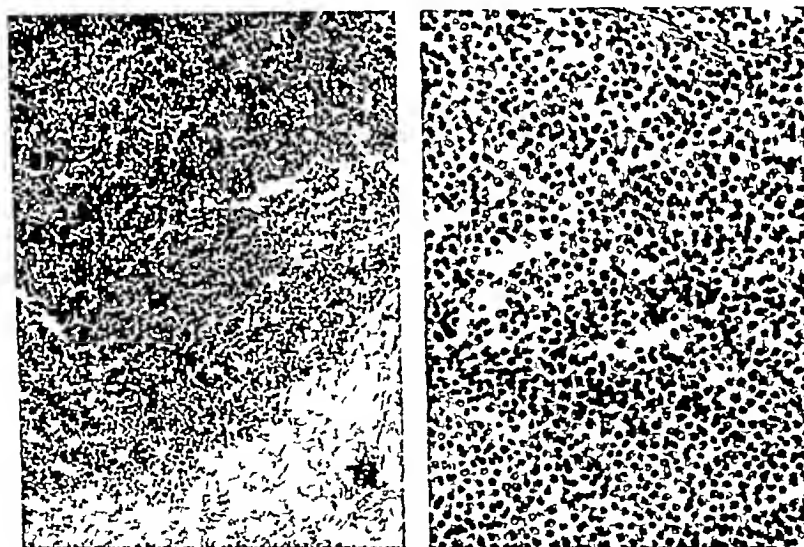


Fig 7 Small round cell carcinoma, grade 4 This histological group made up 5 per cent of our series

occurs rapidly as a result of widespread visceral metastases. The tumors are not radiosensitive, they are composed of rather loosely arranged small round cells growing diffusely and infiltrating capsule and surrounding tissues.

Lymphosarcoma primary in the thyroid gland was noted in 5 of our cases, and they

make up our fifth group and 3 per cent of the series. These lesions are very radiosensitive.

The sixth group contains 5 cases which Dr Stewart has classified as metastasizing struma. These tumors make up 3 per cent of our series and represent those cases in which thyroid metastases were histologically proved but the sections of thyroid gland tissue submitted

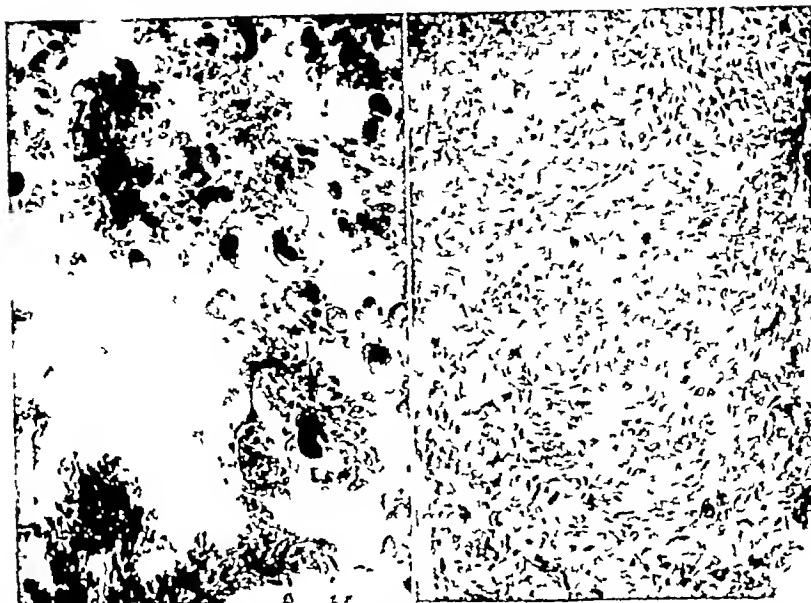


Fig 9 Smear and sectioned clot of aspiration biopsy Spindle and giant cell carcinoma, grade 3 In the pre-operative differential diagnosis of thyroid cancer, aspiration biopsies such as this established a definite diagnosis of cancer in 83 per cent of the cases in which it was attempted

patients, there were 2 instances in which formal surgical biopsy had been carried out before admission and indefinite material obtained. Aspiration biopsy established the diagnosis of thyroid cancer in each of these cases. If one has a positive pre-operative diagnosis, it is much easier to plan the proper treatment and carry out, with a clear conscience, a long, difficult, and cosmetically unpleasant operation which will change the contour of the patient's neck, paralyze the trapezius muscle and considerably alter the speaking voice.

Frozen section at operation is mentioned here only to state that in our hands it has been unreliable. We have had several reports of "no cancer" when later sections demonstrated the presence of definite neoplastic tissue. We believe the experienced cancer surgeon, when impressed at operation with the possibility that he is dealing with cancer, is justified in proceeding with a suitable type of operation regardless of the frozen section and aspiration biopsy reports.

TREATMENT

In discussing therapeutic measures for the management of the patient with cancer of the

thyroid, a number of individual circumstances and conditions must be considered and treatment altered accordingly. But, examining the problem from a broad viewpoint, it seems well established that surgery and radiation will play complementary rôles in the proper care of patients with this disease. This attitude is shared by the larger American clinics doing this work (Pemberton, Lahey, Crile). Several years ago, while operating for cancer of the thyroid and applying to the problem principles which have been found acceptable for radical neck dissection in general, it became necessary to carry out the following operative procedure which we feel is worthy of reporting. As to anesthesia (Table VII) our opinions are definite. We have tried rectal, intravenous, and inhalation anesthetics for neck dissection.

TABLE VI —SIXTY-TWO PRIMARY OPERABLE CASES

Pre-operative diagnosis —	Cases	Per cent
1 Adenoma	11	18
2 Carcinoma	51	82

In a series of 62 primary operable cases of thyroid cancer, the operating surgeon made an inaccurate pre-operative diagnosis of benign adenoma in 11 cases.

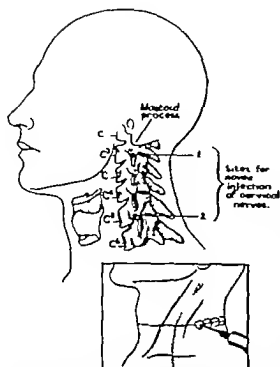


Fig. 9. Novocain anesthesia is used exclusively. Cervical nerve block. 1th per cent novocain is carried out by the Labat technique and the line of incision is infiltrated 1th per cent novocain containing drops of adrenalin in the first ounce. (After Labat.)

and discarded each in favor of novocain local infiltration and cervical nerve block anesthesia (Fig. 10) and to this we attribute the fact that in a series of 12 radical thyroidectomies combined with neck dissection no postoperative death has occurred.

As the operation is to be carried out under local anesthesia (Labat) the patient must be draped in such a fashion as to permit free breathing (Fig. 11). In a protracted operation such as this one a sense of suffocation produced by heavy sheets too close to the mouth and nose makes the patient apprehensive and uncomfortable and, when the surgeon has cut

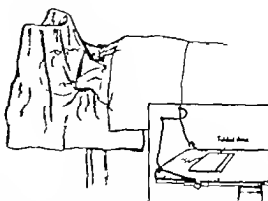


Fig. 11. Position of patient with drapes. As the operation is performed under novocain anesthesia, method of draping is necessary. Each fulfills sterile precautions and yet permits the patient to breathe normally and allows the surgeon and his assistants adequate elbow room.

the recurrent laryngeal nerve and is dissecting the tumor from the trachea, there will be less technical difficulty if the patient is not struggling for air. A satisfactory drape must also permit the surgeon and his assistants adequate elbow room.

An incision is selected which will provide the widest exposure for the individual case (Fig. 12). A generous exposure is necessary for safety and for complete removal of the disease and the potentially involved veins and lymph nodes.

The operative procedure which we favor consists of three major steps. First (Fig. 13) the sternomastoid muscle is cut across at its upper third and the internal jugular vein above the superior thyroid vein is doubly ligated and sectioned. This considerably decreases subsequent bleeding. The sternomastoid muscle is then severed close to its bony origins and the internal jugular vein clamped and doubly ligated and severed just above the angulus venosus. The lowest thyroid veins are also ligated and severed.

The second step (Fig. 14) consists mainly in sectioning the sternohyoid and sternothyroid muscles at their origins and insertions. At this point the posterior cervical triangle and the retrosternal spaces are dissected free of all lymph nodes and surrounding fatty and areolar tissue.

The third step (Fig. 15) consists in dissecting the internal jugular vein and its chain of

TABLE VII.—ANESTHESIA

	No. cases	Per cent
Operations under local anesthesia	73	83
Operations under general anesthesia	14	6
Total	87	

Local anesthesia is preferred for both minor and major thyroid surgery in 84 per cent of the cases.

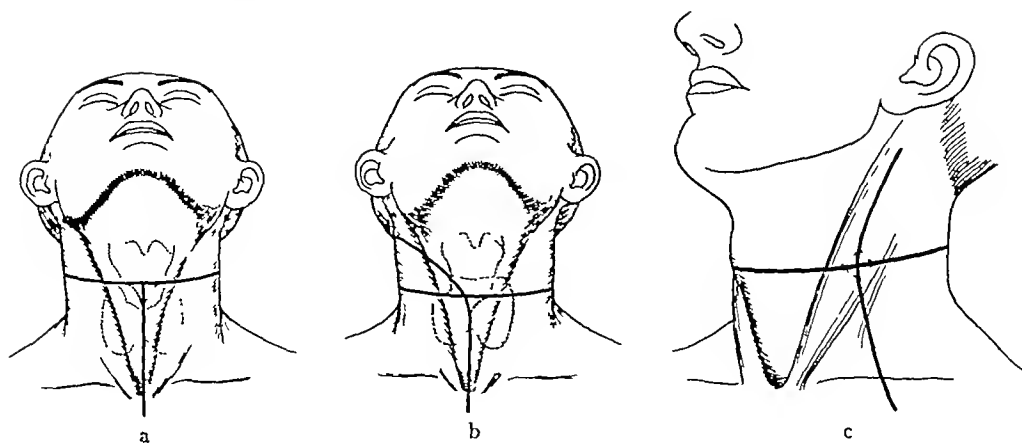


Fig 12 a, Incision A high collar incision at the level of the cricoid cartilage extending to the lateral borders of both sternomastoid muscles. A vertical limb bisects this and continues downward to the suprasternal notch. b, A high collar incision bisected by a curved incision from

the tip of the mastoid process to the suprasternal notch. c, A high, wide collar incision bisected by a curved incision from the tip of the mastoid process to the midclavicle. This permits ready access to the posterior cervical triangle and subclavian space.

nodes free from the vagus nerve and common carotid artery (Watson)—these structures may be sacrificed if invaded—then cutting across normal thyroid at a safe point and removing the entire mass from the trachea and esophagus by sharp dissection. The recurrent laryngeal nerve is always sacrificed. The wound is drained with three or four large cigarette drains, platysma and skin closed, and a large sea sponge pressure dressing applied.

OPERATIVE MORTALITY

Eighty-six patients had a total of 104 operations and of this group 51 cases could be classified as primary operable and 1 patient, a total thyroidectomy, died after operation. In the 12 instances in which radical thyroidectomy with neck dissection was carried out, there was not a single operative death (Table VIII).

The palliative operative procedures for temporary relief of dyspnea and dysphagia resulting from advanced thyroid cancer are attended by a high operative mortality. Tracheotomy, for example, was followed by death in 50 per cent of 14 late cases in which it was carried out in attempting to relieve dyspnea.

Before an operation for thyroid cancer is started, we elect to have at hand in the operating room a sufficient quantity of interstitial radon for our needs in case the tumor cannot be removed. For a large growth this means at

least 70 millicuries, preferably in seeds of about 2 millicuries each. Large doses of interstitial radon can be used with safety if the seeds are carefully distributed so as not to concentrate the reaction and produce necrosis of vital structures. The larger the excised portion of tumor, the smaller the total amount of radon which will be necessary for control of the irremovable portion. Having large amounts of radon at the surgeon's disposal is one advantage offered to the patient by the well equipped modern cancer institute.

TABLE VIII — OPERATIVE MORTALITY—86 PATIENTS—104 OPERATIONS

Operation	No cases	No deaths	Per cent
Partial thyroidectomy	28	0	
Partial thyroidectomy and excision of nodes	7	0	
Total thyroidectomy	3	1	33
Radical thyroidectomy	12	0	
Radical neck dissection	1	0	
Biopsy and exploration	4	1	25
Decompression	8	1	13
Excision of recurrences	10	1	10
Exposure of node and implantation of radon	15	1	7
Tracheotomy	14	7	50
Gastrostomy	1	1	100
Excision of tumor base of tongue	1	0	
	104	13	

In a series of 51 radical procedures for thyroid cancer, 1 patient died—less than 2 per cent operative mortality. The palliative operations resulted in a high mortality.

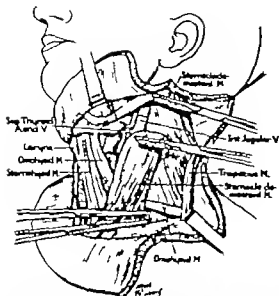


Fig. 3. Step 1. The skin and platysma flaps have been dissected up and the sternomastoid muscle cut across at the hyoid level. The upper site of ligation of the internal jugular vein is indicated. The incision across the clavicular portion of sternomastoid muscle is shown.

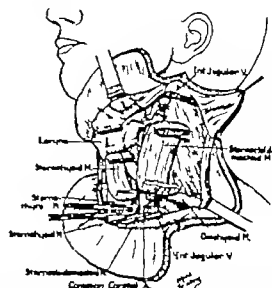


Fig. 4. Step 2. The internal jugular vein has been ligated and cut above and below. The prethyroid muscles are being cut across all above and below the tumor. The submental and supraclavicular spaces are dissected at this stage.

If postoperative radiation is to be given, we recommend divided doses of x-ray therapy given with a 200 kilovolt machine having a filter of $\frac{1}{2}$ millimeters copper and 1 millimeter aluminum. The treatments are given through a portal about 14 by 7 centimeters placed

obliquely along the operative side of the neck from the angle of the mandible to the supra sternal notch. Treatments of 500 roentgens are given every 2 days for a total of about 3,000 roentgens. We believe postoperative irradiation to be effective should be pushed up to a dose sufficient to kill cancer cells if they remain. The mild postoperative "x-ray cycle" has no place in the management of thyroid cancer.

TABLE IX—PRIMARY REGRESSION AFTER PRIMARY RADIATION—81 CASES

Pathology	No. Cases	Degree of regression				
		None %	Slight %	Mod. arct. %	Mar. Lat. %	Complete %
Small alveolar and solid adenocarcinoma	24	46		29	6	
Papillary adenocarcinoma					24	25
Spindle and giant cell adenocarcinoma		23				
Unclassified adenocarcinoma	12	24	16		24	
Lymphosarcoma					23	47
Metastatic squamous			100			
Small round cell carcinoma		100				
Total	81	42	9	27	24	22

Papillary adenocarcinoma of thyroid origin is fairly radiation sensitive. Other types, however, are not sensitive to the usual radiation measures.

RADIOSENSITIVITY OF THYROID CANCER

In 81 cases in which it was possible to judge the effect of primary radiation on thyroid cancer it was noted that 32 per cent of the papillary adenocarcinomas responded well to radiation therapy and all the lymphosarcomas showed marked or complete primary regression of disease but the patients all died of their disease. The other histological types were for the most part quite radioresistant, this quality being most marked in the spindle and giant cell forms of this disease (Table IX).

METASTASES

When metastases to the lung and skeleton have occurred and pain becomes a serious fac-

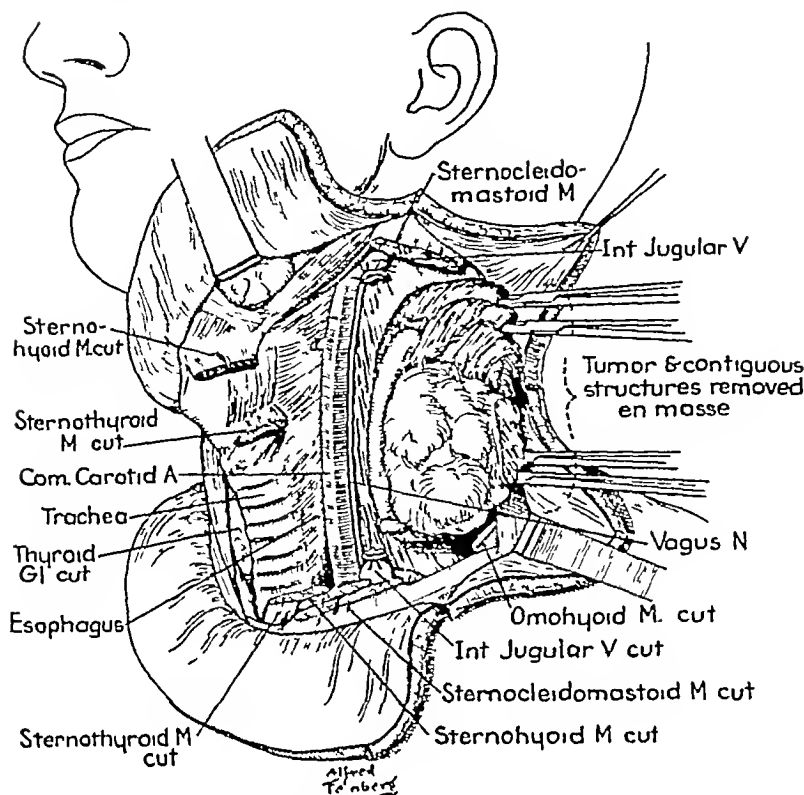


Fig 15 Step 3 The thyroid tumor with its prethyroid muscles, the internal jugular vein, sternomastoid muscle, and contents of the substernal and supraclavicular spaces are removed *en masse*

tor, much relief can be obtained by the judicious use of high voltage x-ray therapy. Advanced thyroid cancer gives rise to widespread metastases (Fig 16) in a considerable percentage of the cases. Seventy-eight per cent of the series presented developed metastases at some time during the course of their disease. Bony metastases occurred in 42 cases (Table X) and lymph node and visceral metastases were noted in 130 instances (Table XI).

A series of 13 cases of thyroid cancer have come to autopsy and the cause of death in 11 was asphyxia resulting from tumor invasion or compression of the trachea. Widespread visceral and bony metastases caused 1 death and the thirteenth patient with generalized metastases died as a result of hemorrhage from an ulcer of the nasopharynx resulting from advanced cachexia.

A peculiar, low grade, persistent, spiking fever is often noted in the advanced stages of

TABLE X —PATHOLOGY OF PRIMARY LESION IN 42 CASES WITH BONE METASTASES

Pathological type	Total cases	Vertebrae	Pelvis	Skull	Ribs	Sternum	Femur	Scapula	Clavicle
Papillary	12	3	6	1	4	0	2	0	0
Small alveolar type	15	10	2	5	2	4	1	1	2
Adenocarcinoma, unclassified	7	3	2	1	1	3	2	1	0
Spindle and giant cell	3	0	0	0	0	0	0	1	0
Small round cell	2	0	0	1	1	0	0	0	0
Metastasizing struma	3	3	0	1	0	0	1	0	0
Lymphosarcoma	0	0	0	0	0	0	0	0	0
Total	42	21	10	9	8	7	6	3	2

All types of thyroid cancer may metastasize to bone but the small alveolar adenocarcinoma is most prone to do so.

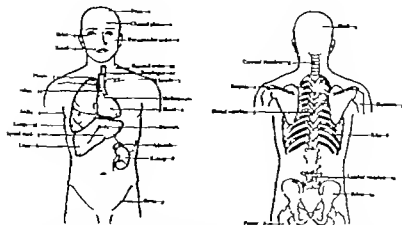


Fig. 6. Showing the site of metastases from thyroid cancer. One hundred and thirty of the entire series of 67 cases developed metastases at some time during the course of the disease.

thyroid cancer. Especially is this true when widespread metastases are known to exist. Basal metabolism rates taken on our patients with widespread visceral and bony metastases from thyroid cancer failed to show any consistent trend; some were normal while others showed moderate plus or minus readings.

CASE REPORT

Mrs. R.B. age 39, white, born in the United States was admitted to Memorial Hospital Clinic

TABLE VI.—PATHOLOGY OF PRIMARY LESION IN 130 CASES WITH LYMPH NODE AND VISCERAL METASTASES

Pathological type	Total cases	Cervical nodes	Subclavicular nodes	Tracheal nodes	Other lymph nodes	Metastases	Lungs	Trachea and bronchi	Prostate	Liver	Other organs
Papillary		15	12				8				
Follicular type	31	16				14					
Adenocarcinoma, medullary	20										
Squamous and giant cell	20	20				6					
Small round cell											
Metastatic carcinoma											
Lymphosarcoma											
Total	30	77	24			30	21	2	1	1	1

All types of thyroid cancer may metastasize to regional lymph nodes but papillary adenocarcinoma is the most frequent offender.

July, 1938, for diagnosis and treatment. Her chief complaint at that time were lumps in the neck and fatigue of 8 months duration.

Eighteen months before admission to the hospital patient developed a small lump in the right side of her neck. This increased slowly in size and others appeared in both the right and left sides of her neck. Some time later she developed a sense of pressure in the neck and on several occasions noted pain in the right side. She gained about 3 pounds in weight in 8 months. The patient had always been in good health, but she had had laparotomy for ovarian cyst in 1932. Twenty-one months before admission to the hospital she gave birth to a baby after normal pregnancy.

On examination the right side of the neck was found to be diffusely enlarged, especially the lower third. This was brought about by mass of discrete nodes lying for the most part underneath the sternomastoid muscle. The nodes were firm, discrete and varied in size. The largest one was about 3 centimeters in diameter and the smallest one about 1 centimeter in diameter. One node was fairly firmly attached to the right side of the trachea. The thyroid was diffusely enlarged but soft.

Labatory data. One of the right neck nodes was removed October 10, 1938 and microscopic examination of the tissue revealed "papillary adenocarcinoma of unusual structure suggesting bronchiogenic rather than thyroid origin. Her blood Wasserman was negative. X-ray films of the chest were negative for metastases.

Treatment. The patient was admitted to Memorial Hospital November 5, 1938 for a radical right neck dissection. This was performed under local infiltration and cervical nerve block anesthesia with 1 per cent novocain. A slightly curved incision as made extending from the mastoid region down to the midportion of the clavicle; the convexity of the curve

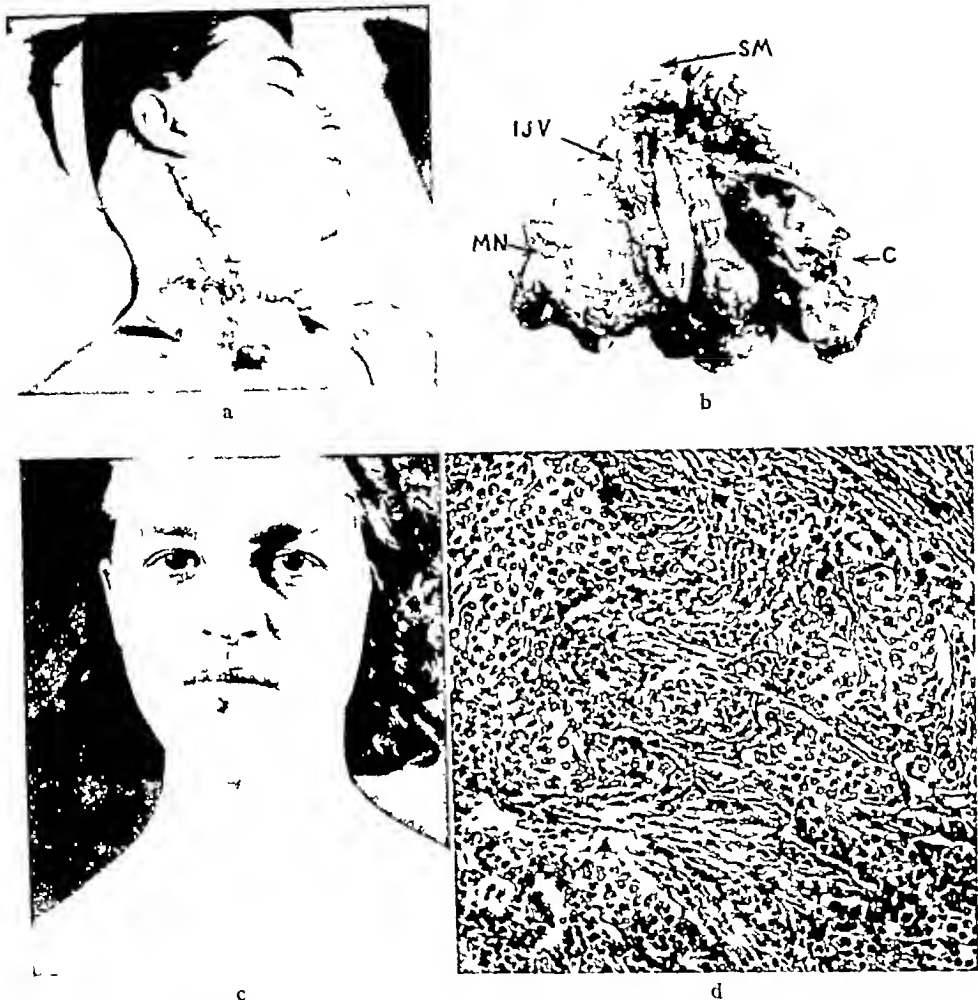


Fig 17 R B a, Immediately after radical thyroidectomy under local anesthesia b, Specimen removed at operation showing primary cancer, C, metastases, MN, inter-

nal jugular vein, IJV, and sternomastoid, SM, and prethyroid muscles *en masse* c, Showing altered contour of the healed neck d, Papillary adenocarcinoma

being slightly anterior. The incision was then crossed by a transverse incision extending from the anterior border of the trapezius muscle directly forward, overlying the prominence of the laryngeal cartilage and extending slightly to the left of the midline. The four skin flaps thus made were dissected exposing the neck structures. Exposure revealed chains of metastatic nodes along the superior thyroid vessels, adherent to the internal jugular vein and also extending below the sternum along the course of the lowermost thyroid veins. Another group of nodes was noted in the posterior cervical triangle. The tumor was mobilized by resecting the sternomastoid and the prethyroid muscles. The internal jugular vein was sectioned above its superior thyroid branch and below the inferior branch. The primary tumor,

right lobe, and isthmus of thyroid gland, the internal jugular vein, prethyroid and sternomastoid muscles, together with the contents of the posterior cervical and substernal triangles were removed in one mass as shown in Figure 17b. The wound was closed with two large cigarette drains and a bulky pressure dressing was applied.

Final diagnosis carcinoma of the thyroid with metastases to the right neck and substernal lymph nodes.

Pathological diagnosis papillary adenocarcinoma of thyroid, grade 2, metastatic to nodes.

The patient's postoperative course was uneventful. Paralysis of the right side of the tongue with some atrophy and paralysis of the right side of the larynx developed. Her basal metabolism rate about

weeks after the operation was minus 3. Her voice and larynx symptoms gradually disappeared and he gained weight. At the time of operation her weight was 145 and at the present time it is 164½. The basal metabolism rate March 30 1939 was minus 9. Patient is taking ¾ grains of thyroid extract each day (Fig. 7).

END-RESULTS

In discussing end-results in thyroid cancer one must necessarily consider survival rates rather than cure rates, because we know that this disease may recur or metastasize many years after treatment. In the present series 2 cases are included in which fatal thyroid cancer recurred locally 16 years after the original treatment, and one of these patients coming to autopsy had massive metastatic thyroid cancer in the mediastinal lymph nodes but no cancer in the neck.

As present methods of treatment were not in vogue prior to 1934, little of value is to be derived from a study of the 5 year survival. However of the original group of 167 patients there are 53 living 4 for 10 years or more 9 from 5 to 10 years, and 26 less than 5 years—all free of disease.

SUMMARY

1. A series of 167 cases of carcinoma of the thyroid is examined from both the surgical and radiotherapeutic viewpoints.

2. Papillary adenocarcinoma is the most common form of malignant thyroid lesion.

3. Lymphosarcoma, apparently primary in the thyroid gland was noted in 5 instances.

This lesion proved radiosensitive. Cancer occurred in the lingual thyroid in 3 cases.

4. Thyroid cancer cannot be classed as a radiosensitive type of new-growth. It responds best to a combination of surgery and interstitial radiation in the form of gold filtered radon seeds.

5. A pre-operative diagnosis of thyroid cancer was confirmed by aspiration biopsy in 83 per cent of the 74 cases in which it was employed.

6. An operation designed to remove a malignant thyroid lesion together with the major cervical veins and lymph nodes of the affected side is described. There was no operative mortality in the small series in which this procedure was carried out.

7. Fifty three patients of the original 167 are living and 4 are free of disease 10 years or more 9 for more than 5 years, and 26 for less than 5 years.

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CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF TEXAS

SPLENECTOMY

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THE mortality following splenectomy was given by W J Mayo in 1928 as 10 per cent and by Pemberton as 6 7 per cent Elason and Ferguson give it as 13 7 per cent in all cases and 34 per cent in the acutely ill The complications commonly recorded as associated with splenectomy are hemorrhage, thrombosis of the portal circulation, disruption of the abdominal wound, and injury to the diaphragm and pancreas

Temporary occlusion of the splenic artery preliminary to splenectomy has been advised by Miller, Cutler, and others, while permanent occlusion has been more often used Ligation alone as a substitute for splenectomy in extreme cases has been practiced extensively by Alessandri and others Obviously, splenectomy is preferable because ligation of the artery reduces the blood supply to the spleen only temporarily

The indications for splenectomy, the pre-operative preparation, and the postoperative care should be given serious consideration Postoperative thrombosis of the portal system is an acknowledged danger about which little can be done, but the loss of blood at or following operation is the most serious complication one has to anticipate My respect for this complication dates back to the first splenectomy I ever witnessed during my medical school days Though an excellent surgeon was operating upon a difficult spleen, veins were torn and a fatal hemorrhage resulted

We offer a technique for splenectomy which has served us well, the chief advantage of which is an incision that gives adequate exposure and allows the surgeon complete control of the situation even in cases in which the liver, as well as the spleen, is greatly enlarged

The patient is tilted slightly to the right side The skin incision is begun at the mudepigastic line, half way between the ensiform and umbilicus, and is extended laterally and downward to just above the crest of the ilium, which is in the line of the fibers of the internal oblique muscles The

anterior sheath of the rectus muscle is incised and the incision is carried across the fibers of the external oblique fascia to where it becomes muscular The rectus sheath is dissected off its muscle upward and downward for a short distance and the muscle is retracted medially This exposes the posterior sheath which is incised across from the linea alba outward and downward and between the fibers of the internal oblique The transverse muscle is cut in the same line without separating it from the internal oblique The tenth intercostal nerve is retracted with the rectus muscle, while the eleventh nerve is cut and the twelfth is retracted laterally

The use of a gastric suction tube put in place before the anesthetic is started, to collapse the stomach, gives greater room, and if it is retained for 24 to 48 hours it lessens the danger of displacing ligatures off the greater curvature of the stomach and also results in a smoother convalescence

The ligation of the splenic artery is an important second step In the very obese the vessel may not be visible, but its pulsation will be felt



Fig 1



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5

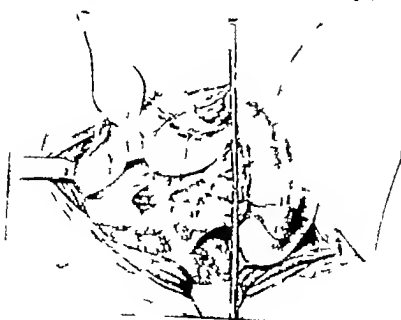


Fig. 6



Fig 8



Fig 9

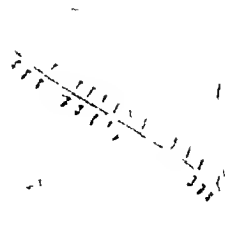


Fig 10

along the upper border of the pancreas when the lesser peritoneal cavity is opened. Care should be taken not to tear or include the splenic vein in the ligature. Almost immediately the spleen will reduce in size, thus making the gastrosplenic vessels accessible for severing between ligatures placed well away from the stomach. The separation of the spleen from the splenic flexure of the colon and upper pole of the kidney is next done, with careful ligation of all structures severed. Only now should the spleen be delivered out of the abdomen. After the spleen has been freed of its attachment to the diaphragm, the remaining hilus structures are clamped and then ligated. Following removal of the spleen, there is good exposure of the diaphragm

and oozing vessels may be clamped and tied or coagulated with the radiocautery. Thus a dry bed is left and the necessity of packing with gauze is obviated. A continuous stitch sutures the posterior rectus sheath and the transverse and internal oblique muscles with the peritoneum. A second suture closes the anterior rectus sheath and external oblique fascia. A strong abdominal wall results.

The incision is unanatomical in that the fascia of the external oblique, as well as of the transverse muscle, is cut across its fibers. The injury to the intercostal nerve leaves no permanent evidence of damage, either to sensation or to muscle control.

THE REPAIR OF INGUINAL HERNIA

A Standardized Technique

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THE purpose of this paper is to review certain factors regarding the diagnosis and treatment of inguinal hernia and to present a standardized technique which we have successfully used in a large series of cases.

Almost all present day operations for the repair of inguinal hernia, direct or indirect, are modifications of the Bassini or Halsted technique. Bassini first devised his method of repair in 1884 and Halsted (3) his in 1888. The use of fascia in operations for hernia was first reported by McArthur in 1901. He utilized strips of fascia derived from the aponeurosis of the external oblique in conjunction with the Bassini method of repair. Ferguson was the first to place the cord external to the aponeurosis of the external oblique. His method of repair was published in 1899. Kirschner in 1910 reported 40 successful operations in which he used a free flap of fascia lata secured by separate incisions in the thigh and sutured ventral to the conjoined tendon.

The anatomic basis. In its migration from the lumbar region of the abdomen into the scrotum the testicle is preceded by a portion of the peritoneum, the processus vaginalis, which normally becomes obliterated shortly after birth. The various types of indirect hernia which develop will depend upon the amount and degree of obliteration of this funicular process. The sac comes obliquely through the abdominal wall by virtue of its close association with the spermatic cord structures. An indirect hernia is therefore considered to be of congenital origin.

Zimmerman states that the conviction grows that the underlying predisposing anatomical basis for direct hernia consists of a congenital absence of adequate muscular support for the lower portion of the inguinal canal. He believes that this further explains the fact that most men go through life doing hard labor and do not develop direct hernias whereas others, who are relatively inactive, have direct hernias before middle life is

reached. Although direct hernias are considered to be acquired, attempts have been made to explain them on a congenital basis as well.

Differential diagnosis. Since the sac of a direct hernia pushes its way through the abdominal wall in an area known as Hesselbach's triangle the tip of the examining finger when inserted through the external inguinal ring will appear to pass directly into the pelvic cavity. The floor of Hesselbach's triangle is formed by the transversalis fascia, the base by Poupart's ligament and the superior ramus of the pubis, the lateral boundary by the deep inferior epigastric artery and the medial boundary by the lateral portion of the straight muscle of the abdomen and its sheath. If firm resistance is felt by the examining finger in Hesselbach's triangle and an impulse is palpated in association with the cord structures, the diagnosis of an indirect hernia can be made. The patient should be examined in both the erect and recumbent positions. Very little pain is associated with direct inguinal hernias and they seldom become incarcerated because of the wide mouth of the sac and the direct course which the sac follows from the abdomen. The sac of a direct hernia does not enter the scrotum because there is no connection with the spermatic cord structures. In certain cases in which a double, saddlebag or pantaloon type of hernia is present, the accurate pre-operative differentiation may be difficult. The fact that bilateral inguinal hernia is present is of no significance in diagnosis since either type may be bilateral.

When a direct hernia is found at operation careful search should be made of the cord structures at the internal inguinal ring for the presence of an indirect sac or of a pantaloon type of hernia. Failure to examine the cord structures carefully accounts for a small number of recurrences, which are, in fact, hernias overlooked at the first operation.

TECHNIQUE OF OPERATION

An average of 41 inguinal hernia operations are performed each year at Hines Hospital. Because of this large number of cases, a satisfactory uniform technique has been devised and used by one of us (P. F. B.) for many years. Although the

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follow-up system has not been 100 per cent in all cases, the number of recurrences is considered to be less than 3 per cent for both the direct and indirect types. The majority of the patients live in the vicinity of Hines Hospital and return voluntarily for follow-up or for other conditions, which provides an opportunity for check-up. Since the results have been so successful over a period of years in a large series of cases, we believe a description of the operative technique is worth reporting.

Spinal anesthesia is used wherever possible. If a bilateral inguinal hernia is present, 200 milligrams of procaine is inserted intraspinally between the second and third lumbar vertebræ, if a single hernia is present, 150 milligrams of procaine is used (8). In addition to preparation of the operative site with an antiseptic solution, a piece of gauze saturated with the solution is placed about the penis and scrotum to prevent infection. The pubic spine and cord structures are carefully palpated and the incision is made obliquely upward midway between the rectus border and Poupart's ligament (Fig 2). If necessary, the incision is extended over the pubic spine. The fibers of the external oblique aponeurosis are incised above the level of the internal inguinal ring and the flaps are reflected to either side. The ilioinguinal nerve is placed aside in order not to damage it. The spermatic cord structures are opened near the internal inguinal ring so that a careful search can be made for the presence of a hernial sac. A sac of the indirect type can then be separated from the cord structures which are held out of the field of operation by means of a piece of cord tape. The cremasteric muscle and fat are dissected free of the cord. The sac is carefully dissected free down to its neck, opened, and its contents replaced within the abdomen, drawn together by purse-string sutures at its neck, and excised (Fig 1). The stump of the sac is allowed to retract normally and it is not sutured beneath the internal oblique muscle or to any structure. In those cases in which the ligated sac is sutured to the internal oblique muscle it is believed that a potential hernia is created because of the pull on the peritoneum. The floor of the inguinal canal is dissected free of all cremasteric muscle, fat, and all vascular structures which might interfere with proper closure. If a small direct hernia is present, the sac is not incised, but it is reduced and invaginated by means of interrupted sutures in the transversalis fascia which cover over the bulging defect and invaginate the redundant tissue (Fig 3). If the direct hernia is large, it is incised, the redundant sac is excised, and the procedure just described is carried out

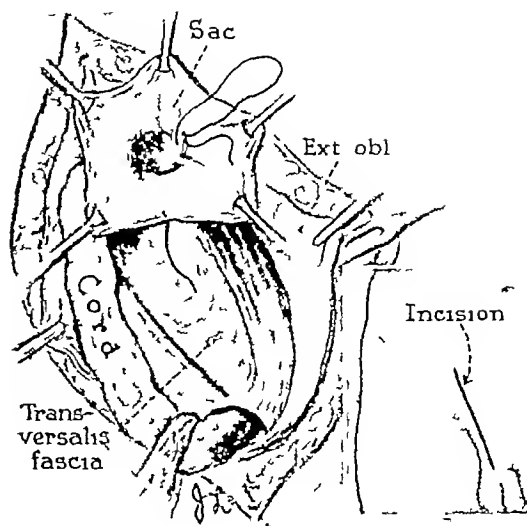


Fig 1

Fig 2

after closure of the base of the sac. The remainder of the repair is the same for either direct or indirect inguinal hernia.

Since the great majority of recurrences develop at or near the pubic bone, the first suture is placed through the periosteal fascial covering of the pubic spine, the conjoint tendon, and the shelving edge of Poupart's ligament. A number of interrupted sutures are taken from this point up to the internal inguinal ring. They approximate the conjoint tendon and the internal oblique to the shelving edge of Poupart's ligament. The angle of the cord structures is changed at the internal inguinal ring by retraction of these structures upward and by placing sutures close to the cord. Two interrupted sutures are also taken above the internal inguinal ring (Fig 4). The lateral flap of the external oblique is then sutured medially beneath the cord to the fascia of the internal oblique and conjoint tendon by means of interrupted sutures (Fig 6). The cord is thus turned medially on the internal oblique by the overlapping lateral flap at the internal inguinal ring for a distance of approximately 1.5 centimeters. Additional sutures are taken above the cord to strengthen this area. The medial flap of the external oblique is incised for about 1.5 to 2 centimeters opposite the cord structures at the level of the internal inguinal ring (Fig 5). The cut edges are then sutured laterally about the cord. The remainder of the medial flap of the external oblique is sutured laterally beneath the cord to the external oblique fascia by interrupted sutures (Fig 7). Suture of the lateral flap of the external oblique medially over the cord at its exit

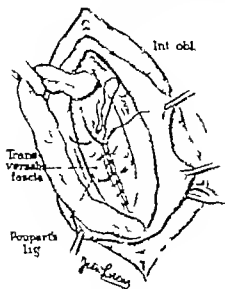


Fig 3

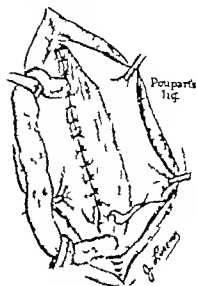


Fig 4

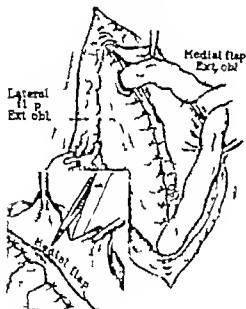


Fig 5

Fig 6



Fig 7

from the internal inguinal ring and then suture of the cut edges of the medial flap of the external oblique laterally about the cord not only change the direction of the cord but make a new internal inguinal ring. A recurrence at this point is therefore quite difficult. The cord structures are transposed between the superficial fascia and the exter-

nal oblique aponeurosis. We have had no complications at the internal inguinal ring from the use of this method.

The conjoint tendon consists of those parts of the internal oblique and the transversalis muscles which unite to insert into the pubic bone (crest and tubercle) in front of the straight muscle of the abdomen. Many variations however are found

in the way these two structures form the conjoined tendon. The conjoined tendon therefore may be almost completely muscular or completely fascio-aponeurotic. We do not hesitate to suture the internal oblique muscle to the shelving edge of Poupart's ligament. If the muscle is traumatized a firm union will result. Although Seelg and Chauke are of the opinion that muscle sutured to fascia does not unite with it but simply forms an adhesion which becomes weakened under pressure, we believe that such union is adequate provided the flaps of the incised external oblique have been sutured over to make a double layer. Russell believes that suture of muscle injures it, prevents its action, and predisposes to recurrence. He also believes that proper removal of the sac alone is sufficient in the cure of simple indirect inguinal hernia. We have had occasion to operate upon patients for recurrent hernia in whom muscle was sutured to fascia and have found a firm union to be present. The removal of the indirect sac and reapproximation of the tissues may be sufficient in children but will prove to be highly unsuccessful in adults.

PRE-OPERATIVE AND POSTOPERATIVE CARE

The patients are hospitalized at least one day prior to operation and are given a complete physical examination, including routine laboratory tests. A soap suds enema is given on the night before operation and on the morning of operation. Just before the patient is taken to the operating room he is given $\frac{1}{4}$ grain of morphine preliminary to the spinal anesthetic.

After operation the patient is placed in a moderately flexed position by elevating the head of the bed (24 hours after operation) and raising the knees. This provides more comfort for the patient and relaxes the tension on the wound. The patient is kept in bed for 14 days and is advised not to do any heavy work for at least 2 months. If he is obese, a reducing diet is advised prior to and following the operation. No abdominal supports of any type are prescribed for use following operation. Gas pains are readily relieved by the insertion of a rectal tube and by the administration of prosthigmine.

EVALUATION

In the past 2000 inguinal hernia repairs, fascial grafts or sutures have not been used in the treat-

ment of more than 3 patients. We believe that if the technique described herewith is carefully executed and the patient is kept in bed for a period of 14 days following operation, there is little need for fascial grafts. Either silk or chromic catgut sutures may be used. In the majority of the patients in this series, chromic No. 1 catgut was used.

Articles have appeared in which it is stated that the risk of complications in operations for bilateral inguinal hernia is nearly twice that of single hernia, also that wound infections occurred more than twice as often in cases of bilateral hernia. This has not been our experience.

We have had no occasion to use the injection method of hernia treatment, with such solutions as synsacol, monolate, proliferol, or neogaltanol. It has been noted, however, in the patients upon whom we have operated who had been given the injection treatment, that the hernias were still present and that the fibrosis produced interfered with the normal tissue planes and made surgical repair more difficult.

SUMMARY

A standardized technique for the repair of inguinal hernia which has been successfully used in an average of 410 patients annually over a period of years is reported. The recurrences number less than 3 per cent. Fascial grafts are not used. Pertinent facts regarding the diagnosis and treatment of inguinal hernia are also reviewed.

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PERIPHERAL VASCULAR DISEASE

A Critical Survey of Its Conservative and Radical Treatment

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EFFECTIVE therapeutics in peripheral vascular disease as in other conditions, is necessarily dependent upon rational considerations of the physiopathological alterations. These changes and their reflected manifestations in peripheral vascular diseases are simply due to a disturbance or actual diminution in the normal amount of circulating blood to a part and are usually the result of a varying diminution in the normal caliber of the peripheral vessels. This decrease in intraluminal volume may be caused by obliterative structural change, by abnormal spasticity or by both, depending upon the type and stage of the disease.

Improvement in circulation is essential for successful therapy and is based upon increasing the blood supply to the part. Obviously this cannot be accomplished by an attack upon vessels which have already undergone structural change. On the other hand, vasospasm is not an unalterable pathological lesion but a physiological or functional derangement which can be satisfactorily influenced by appropriate therapy. Such a rational conception of peripheral vascular disease forms the basis of the classification which we previously described (6; 62) that is, (1) vasospastic functional disease, (2) vasospastic organic disease and (3) degenerative organic disease. It becomes perfectly obvious that vasospasm is of decisive importance because it is the *am controllable factor* and therefore of prognostic and therapeutic significance. However it should be realized that whereas vasospasm may be the predominant feature in certain types of cases in which there is little or no structural vascular change, it exists also in those conditions in which organic vessel disease is the prominent factor. In the latter group vasospasm involves the collateral vessels. Thus, because the degree of vasospasm varies in any given case of peripheral vascular disease it is necessary to determine not only its presence or absence but also its extent.

In previous publications (6; 6) the authors have reviewed and critically analyzed the various diagnostic procedures which may be employed for

the study of and the determination of this phenomenon. Such a survey is beyond the scope of this presentation and the reader who is interested in this phase of the subject is referred to these publications. *It should be emphasized however that without the determination of the presence or absence of vasospasm and its extent, rational therapy cannot be applied.* As previously reported, there are certain clinical factors which indicate the presence or the absence of and in some instances influence vasospasm. These may be grouped as (A) Indicative factors, under which may be classified age, sex, color changes, pallor, and hyperhidrosis and (B) Influential factors, which include emotion, environment, and tobacco.

Because peripheral vascular disease consists of diminution in blood supply to the extremities, therapeutics consists of measures aimed to improve the peripheral circulation and may be divided into two large groups: (1) conservative measures and (2) radical procedures. Generally conservative measures are indicated in all cases of peripheral vascular disease except in the acute vascular catastrophes and in the rapidly progressive peripheral vascular disturbances. In those instances, however in which the conservative measures fail more radical measures may become necessary. The conservative measures consist largely of two groups: (1) those which are directed toward the elimination of all factors which increase vasospasm and (2) those factors which produce vasodilatation. Both are equally important although on the basis of our experience we are convinced that the elimination of the vasospastic factors is of relatively greater importance because the attempts at vasodilatation are likely to be futile if vasospastic influences are still operative. It is surprising how frequently physicians will attempt to produce vasodilatation in patients with peripheral vascular disease and pay little or no attention to the elimination of vasospastic factors. Simple elimination of these factors frequently will be all that is necessary to restore a normal circulation in the extremities.

The vasospastic factors which are of importance are (1) emotional disturbances, (2) environment, and (3) tobacco. These factors are particularly

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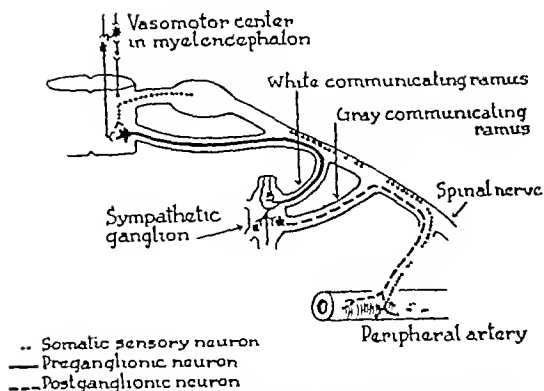


Fig 1 Diagrammatic illustration of vascular innervation showing pathways of vasoconstrictor impulses, the interruption of which forms the rational basis for sympathectomy

important in those peripheral vascular diseases associated with a predominance of vasospasm, namely, the vasospastic functional disease and the vasospastic organic disease, and of less importance in those conditions in which there is little or no vasospasm, such as degenerative organic disease. The control of emotions is frequently difficult but every effort should be made to eliminate those factors which incite such emotions as fear, anger, and worry. Physiological disturbances that occur during periods of endocrine disturbance, such as menopause and menstruation, are also of importance and should be corrected as much as possible.

Environment is of great importance in the production of vasospasm. Although it may be difficult for patients to change environment, it is extremely desirable when such is possible. Although commonly the patient cannot move to a warmer climate and thus avoid the vasospastic influence of exposure to cold, such an individual should take particular care to protect the exposed portions of his body from cold at all times. The wearing of woolen stockings, the protection of the hands and arms with long gloves, the avoidance of contact with cold water, of dampness to the feet, and the necessity of wearing bed socks cannot be overemphasized. Far too frequently, a young girl with a vasospastic functional disease that involves the upper extremities may be warned about the care of her hands and arms but may not be given adequate instructions concerning the protection of her lower extremities and will be allowed to saunter forth in the cold with her ankles and calves protected only by the sheerest silk. In such an instance, the reflex vasospasm of the involved extremities is almost as great as direct exposure of the extremity itself to cold.

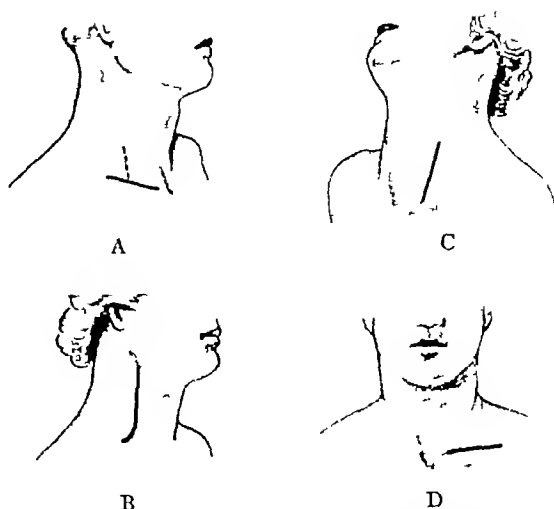


Fig 2 Incisions employed for cervicodorsal sympathectomy by anterior approach. A, Inverted T shaped incision of Royle, 1924 (73). The dotted vertical bar is optional. B, Hockey stick incision of Davis and Kanavel, 1926, used for resection of the entire cervical chain. C, Longitudinal incision between two heads of sternocleidomastoid muscle described by Leriche, 1926 (47, 48). D, Transverse incision of Gash, 1933.

Tobacco smoking is indubitably one of the most important precipitating factors in vasospastic conditions, not because it exerts a more drastic inherent influence than environment and emotion, but because it is more frequently disregarded and is not constantly present. We are so convinced of the vasospastic influence of tobacco that we believe that it is impossible for a patient with a peripheral vascular disease associated with vasospasm to recover as long as there is indulgence in smoking. The definite deleterious effect of smoking upon the vascular system has been shown repeatedly. Numerous investigators have revealed that tobacco produces a marked vasoconstriction of the peripheral vessels in normal individuals as well as in patients with vascular disease. Although some investigators believe that there exists a hypersensitivity to tobacco which is particularly marked in vasospastic organic diseases, others have not been able to confirm these findings. Whereas smoking may be injurious to patients with organic degenerative disease because of the vasospastic influence upon the collaterals, it is especially harmful in patients with vasospastic functional and vasospastic organic lesions.

In addition to the elimination of the vasospastic factors, which as just mentioned is all important, in many instances it is desirable to produce vasodilatation which may be done in one of the fol-

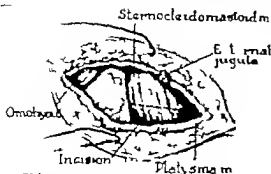


Fig. 3 Coracodorsal sympathectomy by anterior approach as preferred by the authors. After transverse incision as shown in Figure 2 is made the clavicular head of the sternocleidomastoid muscle is either severed or retracted medially and the omohyoid is retracted upward.

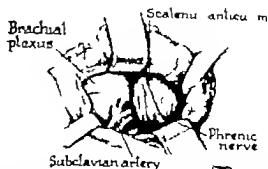


Fig. 4 Exposure of the anterior scalene muscle and the phrenic nerve lying over it is readily accomplished after dissection of the loose areolar fascia has been done. The phrenic nerve should be carefully retracted before division of the anterior scalene muscle is carried out.

lowing different ways: (1) application of heat, (2) drugs and (3) vascular exercises. It is well known that the application of heat to a part will produce normally an increased vascularity. Because of the diminished blood supply to an extremity in a peripheral vascular disease and the resultant inability to carry away an excessive amount of heat applied to such an extremity, the application of heat to the involved extremity is not without danger and should not be used at all or with extreme caution. The application of heat to the involved extremity is not necessary because as shown by Lewis and Pickering (54, 67) and emphasized by Gibbon and Landis (37, 41, 43) application of heat to a localized portion of the body produces a generalized vasodilatation. Thus, equally as good results can be obtained by the application of heat to an uninvolved extremity without the danger of injury to the involved extremity by the heat applied directly to it. A patient with vascular disease of the lower extremity should immerse his hands and arms for 20 to 30 minutes, two to three times a day and, similarly, a patient with a peripheral vascular disease that involves the upper extremity and is associated with vasospasm should immerse the lower part of the body in hot water for 20 to 30 minutes two or three times a day.

Many drugs have been used in the production of vasodilatation. Probably one of the most widely employed and yet one of the most efficacious is alcohol. Generally, we advise these patients to take one or two highballs daily, preferably in the case of the business man before dinner in the evening and just before retiring at night as this will interfere less with his daily routine. Carba-

mylcholine or acetyl-beta methylcholine chloride (mecholyl) is also an efficient vasodilating substance and is of value in the conservative treatment of peripheral vascular disease associated with vasospasm. It may be administered orally, hypodermically, intra-arterially or by iontophoresis. Of the various methods, the subcutaneous administration is probably the most efficacious but has the limitation of requiring a hypodermic injection. Papaverine hydrochloride has also been widely employed especially in acute peripheral vascular catastrophes. More recently, however, it has been shown to be a less effective vasodilator than the simple water immersion procedure. Other drugs advocated are theobromine, sodium thiosulphate and sodium iodide. Theobromine has been found to be of little value in the treatment of peripheral vascular disease and the others are also considered of dubious value. More recently the authors have employed a new drug, beta dimethyl-amino- α -phenyl- α -ethyl-propionic acid benzyl-ester hydrochloride (DL 249) with more promising spasmolytic effects. Histamine administered by iontophoresis has been used by some investigators with reportedly good results. Pancreatic tissue extract and muscle tissue extract have also been advocated as vasodilators. More recently prostigmine and testosterone propionate have also been suggested.

Vascular exercises are of value in some cases of peripheral vascular disease. Buerger originally described the exercises known by his name and found that when systematically used they were of distinct benefit in the promotion of collateral development. Probably of more value than the Buerger exercises are those exercises obtained in

means of a tilting bed. This is particularly true in patients who have progressive lesions and who are confined to bed. Passive vascular exercises by mechanical devices have been used extensively in the treatment of peripheral vascular disease. This form of therapy probably is of greatest relative value in those patients with degenerative organic disease because they have little or no associated spasm. Veal (80, 81) has shown, however, that in those instances in which this method of therapy may be beneficial in patients with extensive collateral circulation, it is of little or no value in those patients who have marked diminution of the vascular bed. Obviously the method has distinct limitations because these patients are in greater need of circulatory improvement. Kountz (39, 40) found that little benefit is derived from the use of this machine and deTakats (21) and Veal (81) believe that the degree of involvement present at the onset of treatment is the most important factor in the determination of the degree of benefit which may be obtained by this form of therapy.

Based upon the original observations of Bier (10), Moszkowicz and Matas, and the extensive studies of Lewis and his co-workers (7, 8, 53, 55, 68) on the principle of reactive hyperemia, intermittent venous occlusion has been developed as a simpler and less expensive method of therapy than passive vascular exercises. Here again, the limitations of this form of therapy are much the same as for the passive vascular exercises. DeTakats (20) found that it had no beneficial influence on pure vasospastic functional disturbances and its limited value has also been indicated by others.

Whereas many of these conservative measures are justified and are usually sufficient to produce complete relief of symptoms, in the rapidly progressive case and especially in the case associated with a prominent degree of vasospasm, attack upon the sympathetic nervous system is considered desirable. The concept that in these vasospastic states sufficient vasoconstrictor impulses are transmitted over the sympathetic pathways to cause diminished circulation and that the release of these impulses may be enough to permit the return of circulation to normal, forms the rational basis for sympathectomy (Fig 1). Interruption of impulses over sympathetic pathways may be accomplished by chemical block or by resection. A chemical block may be done temporarily by the injection of procaine hydrochloride into the appropriate ganglia, or for a longer period of time by the use of alcohol. *Whereas it may appear that block of the regional sympathetic ganglia in peripheral vascular disease is more radical than the use of*

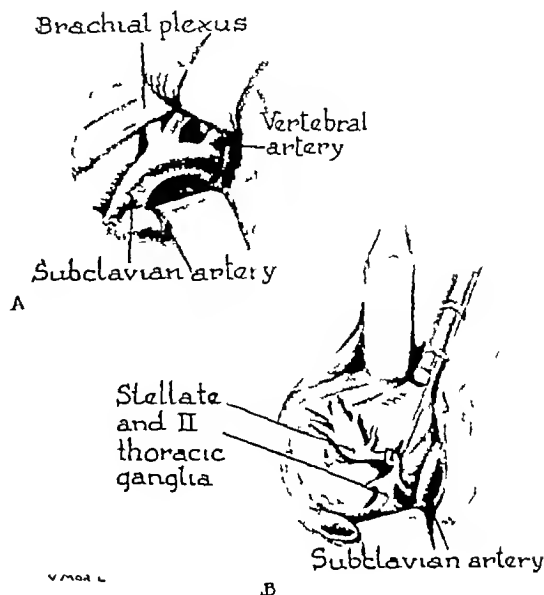


Fig 5 A, Adequate exposure is readily obtained by severance of the tendinous insertion of the anterior scalene muscle. The subclavian artery and its branches, the thyrocervical trunk and vertebral, are then easily identified. Occasionally it may be necessary to ligate and sever the inferior thyroid artery. B, The vertebral artery is retracted medially and the subclavian inferiorly to permit exposure of the stellate ganglion lying just behind the junction of these vessels and directly against the anterolateral aspect of the bodies of the vertebrae. A blunt hook attached to a light is used to hold the ganglion while its rami are freed from the surrounding loose fascia. By mobilizing Sibson's fascia and retracting the dome of the pleura downward, the thoracic trunk can be easily followed as far down as the third or fourth thoracic ganglion.

vascular exercises, actually it is a more conservative procedure because the patient is completely relieved within a period of a few minutes and thus obviates the expense and loss of time required by the prolonged therapy of vascular exercises.

As previously emphasized (61, 62), an alcohol block of the sympathetics should never be done except following a procaine hydrochloride block. The diagnostic significance of this procedure was first championed by Leriche (45, 50), in 1927, and has since been popularized by others. The procedure of the injection of the paravertebral sympathetic ganglia with procaine hydrochloride can be performed with relative facility and safety. The technique has been described previously by the authors (63). Usually the injections are done in the outpatient clinic, since there is no necessity of admission to the hospital for the performance of this procedure. After the insertion of the needles into the appropriate sites, 5 cubic centimeters of

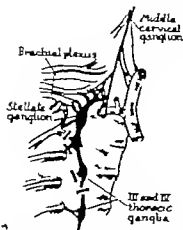


Fig. 6. Diagrammatic illustration of preganglionic sympathectomy as performed by Telford (76). The root of the second, third dorsal ganglia and the trunk below the third dorsal ganglion are sectioned.

per cent procaine hydrochloride is injected through each needle and the needles are allowed to remain in position for approximately 15 minutes. During this time the extremity is carefully watched and appropriate studies are made to determine if the vasodilatory response has been sufficient to justify the injection of alcohol. If vasodilatation occurs, then 5 cubic centimeters of 95 per cent alcohol is injected through each needle and the needles are removed. The patient is allowed to get up in about an hour.

In the presence of marked vasospasm in patients with impending vascular catastrophes or in those patients in whom conservative measures fail to relieve the vascular manifestations, radical therapy is justified. Sympathetic denervation of the affected part, however, should not be per-

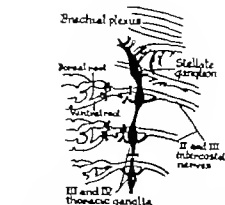


Fig. 8. Diagrammatic illustration of preganglionic sympathectomy described by Smith (75). The procedure consists essentially of dissection of the second and third intercostal nerves into the lateral vertebral foramen, division of the dorsal attachments, section of their anterior and posterior roots, and division of the sympathetic trunk below the third dorsal ganglion.

formed unless the diagnostic test of procaine hydrochloride block has previously demonstrated a satisfactory response of vasodilatation.

In a previous publication the authors (6) reviewed and critically analyzed the common observation that whereas the immediate results following sympathectomy in vasospastic diseases of both the upper and lower extremities are almost invariably excellent, the end results in the lower extremities are considerably better than those in the upper. The not infrequent comparative failure of cervicothoracic sympathectomy to maintain chronic vasodilatation was attributed to such factors as regeneration, the existence of a greater physiological activity of the vasomotor nerves in the lower extremities than in the upper and to incomplete interruption of sympathetic pathways.



Fig. 7. Incisions employed for cervicodorsal sympathectomy by posterior approach. A, Curved incision described by Henry (24). Shaded area of second rib shows portion resected. B, Longitudinal midline incision described by Adams and Brown (93). Although resection of portion of second rib as originally advocated in subsequent description () resection of portion of first rib and trans-

verse process as shown by shaded area, as considered preferable. C, Oblique muscle splitting incision described by White, Smithwick, Allen, and Mirer (56). Either first, second, or both ribs and corresponding transverse processes are resected. D, Vertical para-vertebral incision described by Smithwick (75). Portion of third rib and transverse process are resected as shown by shaded area.

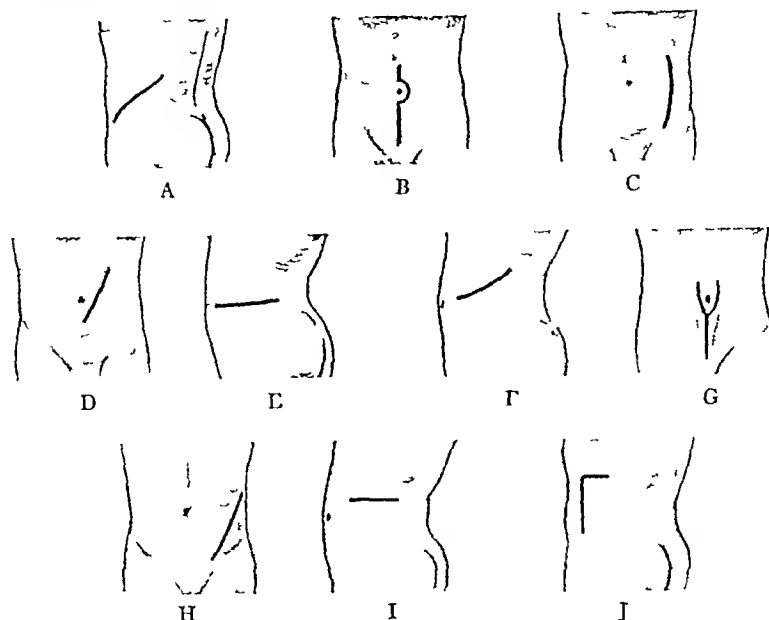


Fig 9 Approaches for lumbar sympathectomy A, Extrapertoneal approach by posterolateral incision of Royle, 1924 (70, 71) B, Transpertoneal approach through anterior midline incision described by Diez, 1925, Davis and Kinnel, 1926, and Adson and Brown, 1929 C, Anterolateral extraperitoneal approach described by Leriche, 1926 (46, 49) D, Oblique anterolateral incision described by Pfeiffer and Livingston, 1935 (65, 66) by extraperitoneal approach E, Transverse incision of Harris, 1935, for extraperitoneal approach F, Anterolateral oblique incision of Flothow, 1935, for extraperitoneal approach G, Y shaped incision of Rees, 1936, for bilateral lumbar sympathectomy by extraperitoneal approach through single incision H, Oblique anterolateral incision of Pearl, 1937, for extraperitoneal approach I, Transverse lateral lumbar incision of Leriche, Pereira, and DeBakey, 1937 (51) for extraperitoneal approach to splanchnics and first and second lumbar sympathetic ganglia J, Inverted L-shaped lateral incision of Smithwick, 1938, for extraperitoneal approach

The most seriously considered explanation has been that of White, Freeman, and Smithwick (29, 30, 82-84) and Ascroft who directed attention to the significant fact that in contrast to the conventional lumbar sympathetic ganglionectomy, which is actually a preganglionic neurectomy, following the customary procedure of cervicothoracic ganglionectomy for the upper extremity, degeneration of the postganglionic neurons occurs with resultant hypersensitization of the denervated vessels to the circulating hormone, epinephrine. This thesis is based upon the original observations of Meltzer and Meltzer (58, 59), Meltzer and Auer (57), and Elliott, and to more recent investigations which revealed in animals that smooth muscle after sympathetic denervation becomes hypersensitive to epinephrine. On this basis, Smithwick (75) and Telford (78) have described and advocated a technique for cervicodorsal sympathectomy in which the preganglionic fibers are sectioned and the postganglionic fibers are left intact.

However, considerable controversy has since developed concerning the relative merits of preganglionic and postganglionic sympathectomy. White (85) and Smithwick (77) have re-emphasized the importance of resecting only the preganglionic sympathetic fibers and Telford (79) concluded that his results in 25 cases were very gratifying. Learmonth also commented favorably upon this form of sympathectomy. Although deTakats (19) reported eminently satisfactory results following preganglionic sympathectomy, more recently (22, 74) he has expressed the opinion that complete sympathetic denervation shows a smaller number of recurrences. In contrast with the views of White, Smithwick, and Freeman are those of Craig and Horton and Fatherree, Allen, and Adson (25, 26). They contend that the successful results following ganglionectomy in Buerger's disease of the upper extremity and the absence of extreme sensitization to epinephrine following cervicodorsal ganglionectomy for con-

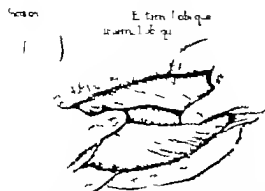


Fig. Anterolateral extraperitoneal approach for lumbar sympathectomy as originally described by Leriche (46, 49) latest shows the slightly curved incision, with its convexity outward along the anterolateral aspect of the abdomen, that extends from a point just below the costal margin to a point about 3 centimeters medial and inferior to the anterior superior iliac spine. The fibers of the external oblique muscle and aponeurosis are separated in the direction in which they run.

ditions other than vasospastic disease militate against the hypothesis of Freeman, Smithwick and White. Moreover Fetherree, Adson and Allen (26) found that whereas increased sensitivity of digital arteries to epinephrine occurred following both preganglionic and postganglionic section for Raynaud's disease of the hands, the degree of increased sensitivity was about the same in both instances. On the basis of their investigations they concluded that the problem of unsatisfactory results that occasionally follow operation

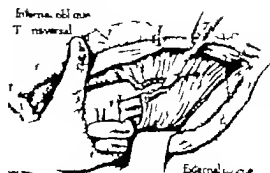


Fig. Anterolateral extraperitoneal approach of Leriche for lumbar sympathectomy showing division of the fibers of the internal oblique and transversus muscle of the abdomen as originally advocated by Leriche.

for Raynaud's disease of the hands has not been satisfactorily solved by a study of sensitivity of digital arterioles to epinephrine. The recent report of Lewis (53) is of particular significance in this regard. He studied 6 patients before and after preganglionic sympathectomy and observed that attacks of discoloration in the fingers occurred spontaneously or were induced in 3 patients within a few days after operation. Although he admits that sympathectomy relieves all patients, it merely lowers the 'whole scale of abnormality'. However, he contends that it does not remove it, because the attacks are not due primarily to excessive action of the vasomotor nervous apparatus. He has always maintained that the disease was due primarily to a local fault which may consist either of occlusion, structural disease, or an increased susceptibility to cold. This is in contrast with the views held by others that sympathetic tone in these patients is abnormally high and that the vasospasm is under a central origin.

Cervicothoracic sympathetic ganglionectomy may be performed by an anterior or a posterior route. It would appear from the literature that the selection of either procedure depends upon personal choice. The authors have employed both approaches and consider the anterior more desirable because satisfactory exposure may be obtained with less operative trauma. It is essential, however, in the employment of either approach that the surgeon have an adequate knowledge of the surgical anatomy of this region.

Cervicothoracic ganglionectomy by the anterior approach was originally performed by Jonnesco (36) in 1896, for exophthalmic goiter and epilepsy. However, Alexander in 1890, is usually credited with having performed the first cervical sym-

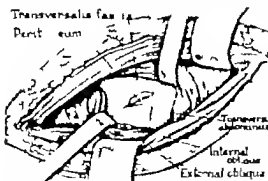


Fig. The authors have found division of the fibers of the internal oblique and transversus muscle of the abdomen unnecessary if good muscular relaxation is obtained by spinal anesthesia. Accordingly, these muscle fibers are separated and not severed. The transcrural fascia is then exposed and incised, care being taken not to lacerate the parietal peritoneum.

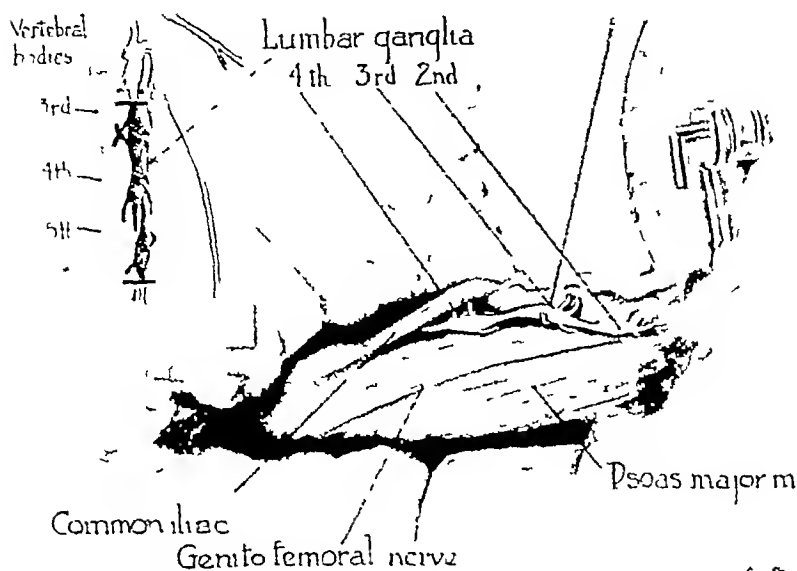


Fig. 13. Anterolateral approach of Leriche for lumbar sympathectomy. By blunt dissection the posterolateral and posterior parietal peritoneum is mobilized medially and held in this position by broad deep retractors. The lumbar sympathetic trunk and ganglia are readily exposed under direct visualization lying between the medial border of the iliopsoas muscle and the anterolateral border of the bodies of the vertebra. The genitofemoral nerve lying on the anterior aspect of the iliopsoas muscle should not be confused with the lumbar sympathetic chain. Blunt hooks are used to pick up the chain and the ram are freed by careful blunt dissection with small firm gauze tampons applied to the end of long curved forceps. The second, third and fourth lumbar ganglia and intervening trunk are excised as shown by the shaded area in the inset.

thectomy for epilepsy. Jonnesco (37, 38) subsequently performed the operation for angina pectoris with a brilliantly successful result. Bruening (12, 13), in 1923, appears to have been the first to employ the procedure for vascular disease. He resected the cervicothoracic ganglia for Raynaud's disease and for scleroderma. In 1924, Royle (70, 71) performed sympathetic ramisection by the anterior route for spastic paralysis and in 1927 (72) he advocated the procedure for Raynaud's disease. Whereas in his earlier publications Royle advocated ramisection only, in subsequent presentations (73) he sectioned the trunk below the stellate ganglion. The approach used by Royle consisted of making an inverted T-shaped incision with the horizontal bar in the suprasternal region and the vertical bar opposite the posterior border of the sternomastoid (Fig. 2, A), reflection of the clavicular attachment of the sternomastoid, and retraction or division of the tendinous insertion of the anterior scalene muscle. Royle stated that the vertical bar of the incision was not always necessary. In 1926, Davis and Kanavel advocated cervicothoracic ganglionectomy for Raynaud's

and other vascular diseases and described a somewhat different anterior approach. These authors used an incision resembling a hockey stick which extended from the inferior angle of the mandible downward to the superior border of the clavicle and crossed obliquely the sternomastoid muscle from its medial to its lateral edge (Fig. 2, B). The superior cervical ganglion and chain are exposed by mobilizing the medial edge of the sternocleidomastoid laterally and the middle and inferior cervical ganglia and chain are freed by mobilizing the lateral edge of the muscle medially. Accordingly the superior and middle cervical and stellate ganglia and intervening trunk are resected.

In 1926, Leriche (47, 48) described a much simpler anterior approach which consists of a longitudinal incision about 6 centimeters in length made between the clavicular and sternal heads of the sternocleidomastoid muscle (Fig. 2, C). The dissection is carried down between the two heads of this muscle and the stellate ganglion is exposed medial to the insertion of the anterior scalene muscle. The anterior approach described by Gask (Fig. 2, D) is essentially the same as that previ-

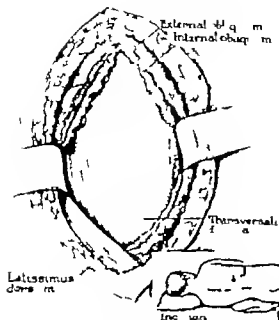


Fig. 4. Extraperitoneal approach of Leriche, Perera, and DeBakey (5) for resection of splanchnics and first and second lumbar sympathetic ganglia. Inset shows position of patient and the transverse incision. Incision is made just below the costal margin to extend from point just anterior to the midclavicular line to the lateral border of the sacrospinal muscle. The fibers of the external and internal oblique muscles are separated and incised thus exposing the fibers of the transverse muscle of the abdomen. Incision is separated in the direction in which they run and the transverse fascia which is incised to expose the peritoneum and retroperitoneal fascia.

ously described by Royce (70-73). The authors have found this approach eminently satisfactory. The clavicular head of the sternocleidomastoid muscle is divided and the omohyoid is either retracted or severed (Fig. 3). The anterior scalene muscle is exposed, the phrenic nerve is retracted medially, and the inserting fibers of the muscle are divided (Fig. 4). This is an important step in the operation because adequate exposure is readily obtained by severance of this muscle (Fig. 5, A). The inferior thyroid and vertebral arteries may be easily identified and should be gently retracted toward the midline. A few nerve fibers from the middle cervical ganglion may be observed looping around the inferior thyroid artery. Occasionally it may be necessary to ligate and sever this artery in order to obtain better exposure. On the left side care should be taken not to injure the thoracic duct. An absolutely bloodless field and good illumination considerably facilitate the operation. By

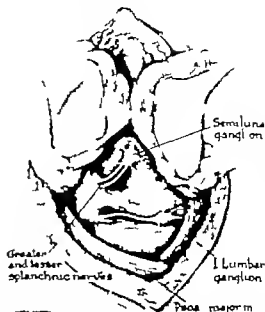


Fig. 5. Continuation of procedure described in Figure 4. The retroperitoneal fascia is gently smoothed forward and held in place by means of deep broad retractors thus exposing the psoas muscle and diaphragmatic crura. The greater and lesser splanchnics are found to emerge from between the diaphragmatic crura and to pass somewhat medially and transversely to enter the semilunar ganglion. The first and second lumbar sympathetic ganglia may be found just below these structures between the anterolateral aspect of the vertebral bodies and the psoas muscle. The splanchnics are severed just before they enter the semilunar ganglion and the first and second lumbar sympathetic ganglia and intervening trunk are resected.

gentle retraction of the vertebral artery medially and the subclavian inferiorly the stellate ganglion may be readily identified lying just behind the junction of these vessels directly against the anterolateral aspect of the bodies of the seventh cervical and first thoracic vertebrae. The ganglion varies in size from 1 to 2 centimeters and in appearance from irregularly oval to dumbbell-shaped. It is readily identified by its white glistening, dense, tough character and by its numerous ramuli which have given it the stellate description and name (Fig. 5 B). A blunt hook is used to hold the ganglion while its ramuli are freed from the surrounding loose fascia by gentle blunt dissection with a small firm gauze tampon applied to end of long curved forceps. We devised a lighted hook which facilitates this procedure. After mobilization of Sibson's fascia the dome of the pleura can be retracted downward and the thoracic trunk easily followed to third thoracic ganglion.

Based upon the investigations stated above which tended to show that the customary cervicodorsal sympathectomy was a postganglionic neurectomy and therefore caused degeneration of the postganglionic neurons with consequent hypersensitization of the denervated vessels to circulating adrenalin, Telford (78) has recently described and advocated a technique in which the preganglionic fibers are sectioned and the postganglionic fibers are left intact. He uses an anterior approach and sections the rami of the second and third dorsal ganglia and the trunk below the third ganglion (Fig 6). On the assumption that the preganglionic components of the first thoracic nerve have no significant function in the sympathetic innervation of the upper extremity, the white communicating ramus of the first thoracic nerve is allowed to remain intact. Kuntz, Alexander, and Furcolo, however, have demonstrated that the preganglionic components of the first thoracic nerve effect synaptic connections with inferior cervical ganglion cells whose axones are relatively widely distributed in the upper extremity. On the basis of these investigations they concluded that in order to produce complete functional sympathetic denervation it is necessary also to interrupt the white communicating ramus of the first thoracic nerve (41).

The posterior approach for cervicothoracic ganglionectomy was originally performed by Henry, in 1922, for angina pectoris (Fig 7, A). The procedure was subsequently modified by Adson and Brown (3, 4). These authors used a longitudinal midline incision that extended from the tip of the sixth cervical spine to the fourth dorsal spine (Fig 7, B). Bilateral ganglionectomy may be performed through this incision by a linear division of the trapezius on either side of and parallel with the spinous processes. The spinous attachments of the rhomboid and posterior serratus muscles are divided and the second rib as well as the second transverse process is resected. The parietal pleura is mobilized anteriorly and laterally and the sympathetic trunk exposed. The stellate and second thoracic ganglia and intervening trunk are resected. Because this procedure did not permit adequate exposure of the lower cervical ganglion and resulted in incomplete sympathectomy, Adson (1) subsequently modified the technique and resected the first rib instead of the second.

Because such an operative procedure produces considerable operative trauma to muscle and consequently increases morbidity, White, Smithwick, Allen, and Mixer (86) modified the technique in an attempt to obviate these difficulties. They use a muscle splitting incision somewhat similar to

that devised by Head and Bigger for extrapleural thoracoplasty (Fig 7, C). The proximal 3 centimeters of either the first or second or occasionally both ribs as well as the corresponding transverse processes are resected and the pleura is mobilized as above.

In order to obviate the postganglionic degeneration and the resultant increased sensitivity of the denervated vessels to circulating adrenalin following the customary cervicodorsal ganglionectomy, Smithwick (75) has recently advocated a procedure which utilizes the posterior muscle splitting approach. It consists essentially of resection of a small portion of the third rib and transverse process, dissection of the second and third intercostal nerves into the intervertebral foramen, division of the dorsal attachments, section of their anterior and posterior roots, and division of the sympathetic trunk below the third dorsal ganglion (Figs 7, D, and 8). Because in this procedure also the white communicating ramus of the first thoracic nerve is allowed to remain intact, the exception taken by Kuntz, Alexander, and Furcolo to Telford's procedure as herein stated is applicable to Smithwick's procedure.

Lumbar sympathectomy may be performed either by the transperitoneal or the extraperitoneal approaches. The former route has the advantage of permitting bilateral ganglionectomy through the same operative wound. On the other hand, the latter procedure has the advantages of not invading the peritoneal cavity, absence of trauma to the intestines, and a more satisfactory postoperative course. In the authors' hands this has been the procedure of choice.

Lumbar sympathectomy by the transperitoneal approach was first performed for vascular insufficiency of the lower extremities in 1924, by Diez (Fig 9, B). This author advocated resection of the lumbosacral cord, i.e., the excision of the sympathetic chain and ganglia from the second lumbar to the third sacral, inclusive. Whereas Adson and Brown (3) performed transperitoneal sympathetic ganglionectomy for spastic paralysis in 1924, they (2) first used this operative procedure for vascular disease (Raynaud's) in 1925. However, they resected only the second, third, and fourth lumbar ganglia and intervening trunk. The technical description of this procedure was first presented by Davis and Kanavel, in 1926, and subsequently by Adson and Brown (3), in 1929. The technique consists of making a midline or paramedian incision that extends from a point 5 to 6 centimeters above the umbilicus to a similar distance below (Fig 9, B). The posterior peritoneal wall is exposed by placing the patient in the

Trendelenburg position and packing the intestines upward and laterally. The chain is exposed by incision of the parietal peritoneum longitudinally along the medial edge of the iliopsoas muscle. On the right side the vena cava is retracted gently and the sympathetic trunk is found lying along the anterolateral border of the bodies of the lumbar vertebrae. Excision of the ganglia and trunk is slightly more difficult on this side because of the lumbar veins which not infrequently pass anterior to the chain. Adson and Brown prefer exposure of the left trunk by incision of the peritoneum along the anterolateral border of the sigmoid and mobilization of this structure medially.

The extraperitoneal approach to the lumbar sympathetic ganglia was originally described, in 1924 by Royle (70, 71) who performed ramsection of the second third and fourth lumbar ganglia and section of the trunk below the fourth ganglion. He (72) subsequently advocated the procedure for vascular disease of the lower extremities. In this approach the incision is made in the posterolateral lumbar region to extend from the twelfth rib above to the crest of the ilium below and then to curve anteriorly and inferiorly to a point just below the anterior superior spine of the ilium (Fig. 9, A). The oblique and transverse muscles of the abdomen as well as the lumbofemoral fascia are divided along the lateral border of the lumbar quadratus muscle. The posterior and posterolateral parietal peritoneum is then mobilized forward to expose the medial aspect of the iliopsoas muscle and the anterolateral border of the bodies of the lumbar vertebrae between which the lumbar sympathetic trunk lies. This approach is somewhat difficult in muscular and bony patients and has the added disadvantage of producing considerable operative trauma to muscle tissue. A much simpler procedure that affords even better exposure is the anterolateral extraperitoneal approach first described by Leriche (46, 49) in 1926. This approach has been subsequently modified by various surgeons. The procedure as described by Leriche and first performed by him in 1915 consists of making a slightly curved incision with its convexity outward along the anterolateral aspect of the abdomen from just below the costal margin above to a point about 3 centimeters medial and inferior to the anterior superior iliac spine (Fig. 9, C). The patient is placed on the table with the operative side elevated to an angle of approximately 30 degrees. The fibers of the external oblique muscle and aponeurosis are separated in the direction in which they run (Fig. 10). The internal oblique and transverse muscles of the abdomen are divided (Fig. 11). The authors have

found this unnecessary if good muscular relaxation is obtained and for this reason employ spinal analgesia. Accordingly these muscle fibers are separated and not severed (Fig. 12). The transversalis fascia is thus exposed and incised, care being taken not to incise the parietal peritoneum (Fig. 3). By blunt dissection the posterolateral and posterior parietal peritoneum is mobilized medially to expose the iliopsoas muscle. Broad deep retractors are used to retract the peritoneum medially and under direct visualization the lumbar sympathetic trunk and ganglia are readily exposed lying between the medial border of the iliopsoas muscle and the anterolateral border of the bodies of the vertebrae covered by loose adipose tissue (Fig. 13). It should be realized that the genitofemoral nerve that lies on the anterior aspect of the iliopsoas muscle may lie sufficiently medial to be confused with the lumbar sympathetic chain (Fig. 13). However it may be readily distinguished from the latter by the fact that it has no ganglia or rami and never lies against the vertebral bodies. On the right side it is necessary to retract gently the vena cava as this structure usually overlies the trunk. Greater care must be exercised in freeing the chain on this side because the lumbar veins usually course anterior to it and accidental tearing of these veins produces annoying hemorrhage. Blunt hooks are used to pick up the chain and the rami are freed by careful blunt dissection with small firm gauze tampons applied to the end of long curved forceps. The second, third, and fourth lumbar ganglia and intervening trunk are excised (Fig. 14).

Slight modifications of this procedure have been described by a number of surgeons. Harris uses a transverse incision that extends from the lateral border of the quadratus lumbar muscle to the umbilicus (Fig. 9, E). A somewhat similar incision is employed by Flothow and the muscle fibers are split in the direction in which they run (Fig. 9, F). Pfeiffer and Livingston (65, 66) (Fig. 9, D) and more recently Pearl described more oblique anterolateral incisions (Fig. 9, H). Smithwick (76) employs an inverted L-shaped anterolateral incision (Fig. 9, J). Rees has described an anterior extraperitoneal approach for bilateral lumbar sympathectomy through a single incision. This consists of a Y shaped incision with the tail of the Y extending longitudinally in the midline below the umbilicus and the two arms of the Y extending upward on each side of the umbilicus (Fig. 9, G). On both sides the anterior rectus sheath is incised and the rectus muscles split. The posterior rectus sheath is similarly incised and the peritoneum and its contents are mobilized medially.

Because no preganglionic fibers join the sympathetic trunk below the fourth lumbar ganglion, Danicopolu (15, 16) and others have considered too extensive the classical operation of resection of the second to the fourth ganglia, inclusive. The procedure which Danicopolu, Aslan, and Marcyn term "interlumbosacral sympathectomy" and which consists of section of the chain at the fourth ganglion is considered sufficient to interrupt vasoconstrictor impulses to the foot. On the other hand, Fontaine and his co workers and Derom have shown convincingly by experimental investigations that in order to obtain a maximum vasodilatation in the lower extremity it is necessary to resect the first lumbar ganglia as well as the second, third, and fourth.

It is common knowledge that peripheral vasoconstriction can be initiated by reflex activity of the autonomic nervous system and also by an increased secretion of epinephrine. Such stimuli as exposure to cold and emotional excitement produce vascular spasm by reflex excitation of vasoconstrictor impulses to blood vessels and by reflexly increasing epinephrine secretion. Thus the mechanism of peripheral vasoconstriction under such circumstances may be humeral as well as neurogenic. Whereas the neurogenic constrictor activity may be diminished by sympathectomy, this procedure may have little influence on the humeral factor. Numerous observers have shown that the humeral factor in some instances may play a significant rôle in vasospastic functional and vasospastic organic conditions. On this basis and in an attempt to decrease also the reflex activity of this humeral factor Leriche, Pereira, and DeBakey (51) advocated simultaneous resection of the splanchnics and first and second lumbar sympathetic ganglia in vasospastic functional and vasospastic organic peripheral vascular disease. This may be readily performed with little or no technical difficulty through a new extraperitoneal approach which they (51) describe. The patient is placed in the lateral decubitus position with the back inclined slightly posteriorly and a pillow under the lumbar region (Fig 14). A transverse incision about 10 to 12 centimeters in length is made just below the costal margin to extend from a point just anterior to the midaxillary line to the lateral border of the sacrospinal muscle (Fig 14). The fibers of the external and internal oblique muscles are separated and incised to expose the fibers of the transverse muscle of the abdomen which are separated in the direction in which they run and the transversalis fascia which is incised to expose the peritoneum and retroperitoneal fascia (Fig 14). This retroperitoneal fascia is gently

mobilized forward and held in place by means of deep broad retractors thus exposing the anterior aspect of the lumbar quadrate muscle, the psoas muscles, and the diaphragmatic crura (Fig 15). The greater and lesser splanchnics will be found to emerge from between the diaphragmatic crura and to pass somewhat medially and transversely to enter the semilunar ganglion. More medial and just below these structures will be found the first and second lumbar ganglia lying between the anterolateral aspect of the vertebral bodies and the iliopsoas muscle (Fig 15).

SUMMARY

1 The bases for rational therapy in peripheral vascular disease are discussed.

2 Peripheral vascular disease merely signifies a disturbance or actual diminution in the normal amount of circulating blood to a part and is usually the result of a varying diminution in the normal caliber of the peripheral vessels. This decrease in intraluminary volume may be caused by obliterative structural change, by abnormal spasticity, or by both, depending upon the type and the stage of the disease.

3 Effective therapy aims at improvement in circulation or increase in blood supply to the part which cannot be accomplished by an attack upon vessels that have already undergone structural change. Vasospasm, on the other hand, is a physiological or functional derangement which can be satisfactorily influenced by appropriate therapy.

4 Because vasospasm is the one controllable factor, the determination of its presence or absence and its extent are of decisive importance.

5 Therapeutics in peripheral vascular disease consists of measures aimed to improve the peripheral circulation and may be divided into two large groups: (1) conservative measures and (2) radical procedures.

6 Conservative measures are indicated in all cases of peripheral vascular disease except in acute vascular catastrophes and in the rapidly progressive peripheral vascular disturbances. The conservative measures consist largely of two groups: (1) those which are directed toward the elimination of all factors which increase vasospasm and (2) those factors which produce vasodilatation. Of the former, emotional disturbances, environment, and tobacco are the most important. Of the latter, application of heat and drugs, and the performance of vascular exercises are the most significant.

7 Whereas many of these conservative measures are justified and are usually sufficient to pro-

duce complete relief of symptoms, in the rapidly progressive case and especially in the case associated with a prominent degree of vasospasm, attack upon the sympathetic nervous system is considered desirable. The concept that in these vasospastic states sufficient vasoconstrictor impulses are transmitted over the sympathetic pathways to cause diminished circulation and that the release of these impulses may be enough to permit the return of circulation to normal forms the rational basis for sympathectomy. Interruption of impulses over sympathetic pathways may be accomplished by chemical block or by resection.

8. Chemical block of the regional sympathetic ganglia in peripheral vascular disease is considered a conservative procedure because of its efficacy, its simplicity and facility of performance and its economic advantages.

9. In the presence of marked vasospasm in patients with impending vascular catastrophes or in those in whom conservative measures fail to relieve the vascular manifestations, radical therapy is justified. Sympathetic denervation of the affected part, however should be performed only after the demonstration of vasodilatation following the diagnostic test of procaine hydrochloride block.

10. The factors which have been considered for the comparative failure of cervicothoracic sympathectomy to maintain chronic vasodilatation are reviewed and critically analyzed.

11. The technical considerations in the performance of cervicothoracic and lumbar sympathectomies for peripheral vascular disease are historically reviewed, described and illustrated.

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THE TREATMENT OF EXTENSIVE WOUNDS

Notes on Six Cases in Which the Injuries Were Caused by a Circular Saw

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IN rural and agricultural districts, where small farms predominate, serious accidents are common and severe injuries of soft tissues and osseous structures in combination frequently result therefrom. Their treatment presents a real problem in reconstructive surgery in which the early restoration of normal structure and function are the ideal criteria of successful therapy. Unfortunately such perfect results are not always possible, but, in striving for those standards, certain essential principles of surgical treatment are imperative. These details fall chronologically into 3 groups: pre-operative, operative, and postoperative. Each group will be discussed separately, and the illustrative cases reported briefly thereafter.

1 Pre-operative When the patient is first seen, bleeding of any consequence should be immediately arrested and all lesions in which there is a break in the continuity of the skin should be protected from further exposure to infection with sterile dressings. Before transportation all suspected and obvious fractures should be immobilized by temporary splints. After complete physical examination has revealed no evidence of intracranial or intra-abdominal injury, a liberal dose of morphine may be administered for relief of pain.

The arrest of hemorrhage, the immobilization of broken bones, and the control of pain are all highly important contributions toward the prevention of traumatic shock. If this condition be present when the patient is first seen, or develops subsequently in spite of these prophylactic measures, its immediate treatment must receive primary consideration before any surgical procedures are undertaken. During this period, frequent observations of the blood pressure, pulse rate, and respiratory rate should be made and recorded on a graphic sheet in order that the surgeon's clinical impression of the patient's condition may be supplemented by a visual record.

When these vital signs have become stabilized at a normal, or nearly normal, level all injured

extremities should be examined carefully to determine the integrity of motor and sensory nerves, of muscles, and of tendons. This procedure is extremely important if the extremity is subsequently to be encased in a cast or even supported by splints.

2 Operative Operative treatment begins with the choice of the proper anesthetic. Unfortunate and undesirable complications—cyanosis, vomiting, aspiration of particles of food, and asphyxia—occasionally follow the use of a general anesthetic soon after a meal. Local infiltration or blockage with novocain is preferred whenever satisfactory anesthesia can be obtained by this method. Local anesthesia also allows the patient, during the operation, to carry out active muscular contractions which afford valuable assistance in the identification of proximal ends of divided muscles and tendons. Spinal anesthesia is useful in injuries and fractures of the lower extremities but is definitely contra-indicated in patients who are on the verge of, or have just recovered from, shock. It is also undesirable in patients with hypertension.

Preparation of the operative field is an important part of every surgical procedure and becomes increasingly important in the treatment of mutilated wounds when the skin has been abraded and recently soiled with gross dirt, the subcutaneous tissues lacerated and devitalized, and the deep structures contaminated by foreign matter. The exposed area should be covered with one or more sterile sponges while the skin is cleansed with green soap, shaved from the edges of the wound toward the periphery, rewashed with soap, and scrubbed gently with some antiseptic solution. Alcohol and ether or a dilute solution of bichloride of mercury are effective and produce little necrosis of tissue. In draping, sterile towels should be placed close to the edges of the wound. Before complete exploration is carried out all devitalized and necrotic tissue should be excised, gross particles of dirt and other foreign bodies removed, and the wound irrigated from the depths outward with warm saline solution, or some very mild antiseptic. All viable tissue should be carefully preserved to be utilized later in the repair.

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The wound may then be thoroughly explored to determine the extent of injury to bones, muscles, tendons, and nerves. The use of a tourniquet is frequently of great assistance in obtaining a dry, bloodless field, and is imperative when major vessels have been divided. The ends of broken bones should be opposed and frequently stabilized by some form of internal fixation. Divided nerves and tendons must be accurately approximated, preferably with sutures of fine silk. The tourniquet should be removed and all bleeding points ligated with the same material before the wound is closed. It is unwise to use both silk and catgut in the same wound.

If the patient is seen within 6 hours from the time of the accident, tissues handled gently, and the aforementioned principles observed, drainage is seldom necessary, after 6 hours, it becomes more imperative as the interval of time increases. If tissues cannot be closed without tension, either some immediate plastic procedure or later secondary operation is necessary for the repair of tendons and nerves. Should the wound become infected, particularly with streptococcus, any secondary repair must be postponed for at least 8 to 10 months.

Some form of external fixation is essential for all injuries of bones, tendons and nerves should be regarded as part of the operative procedure, and applied before the patient leaves the operating table. Extremities must be placed in such a position that divided tendons will be relaxed, and muscles, the nerve supply of which has been interrupted, will be at rest.

3. *Postoperative.* After operation immobilization should be maintained until healing is complete but may be interrupted daily for active and passive motion, within the limits of pain this should be instituted as early as possible and supplemented by physical therapy. When motor nerves have been severed, muscular tone should be maintained by electric stimulation and massage until regeneration has occurred.

In order to appraise one's results accurately the patients must be followed until full recovery has taken place or the disability has become stabilized and permanent.

REPORT OF CASES

In each of the following cases the injuries were caused by contact with a portable, circular buzz saw. Trauma inflicted by such an agent produces extensive lacerated wounds of muscles, tendons, and nerves with communicating injuries of bones and joints which are more comparable to wounds of war than any others seen in civil practice.

CASE 1 Hospital No. 703 C. B. farmer 36 years of age, slipped and fell onto rotary saw in such manner that the volar surface of the left wrist came in contact with the whirling blade. He sustained deep, lacerated wound with widely separated edges, division of the radial and ulnar arteries, the median and ulnar nerves, and the tendons of the palmaris longus, the flexor carpi radialis, the flexor sublimis and profundus digitorum.

At operation the wound was cleansed and debrided, the arteries ligated, the nerves and tendons approximated. Interrupted sutures of fine silk, and the wrist immobilized in slight flexion, with volar splint of plaster. Physical therapy and passive motion within the limits of pain were instituted on the tenth day. Eleven months later all motions of the hand and fingers were normal save adduction of the thumb and little finger; there was some atrophy of the thenar and hypotenar eminences (Fig. 1). The patient was able to distinguish pain, light touch, and temperature in the palm down to the palmar/platting creases. He was working with pick and shovel and was able to perform all types of manual and agricultural labor without discomfort or disability. Four years later the condition was unchanged. He considered the function of his hand essentially normal.

CASE 2 Hospital No. 7365 R. C. farmer, 46 years of age, slipped while working with the operation of rotary saw and fell forward on to the whirling blade. She received deeply lacerated wound through the dorsal half of the left forearm below the elbow. The radius and ulna were divided and the elbow joint was widely opened, exposing the capitulum of the humerus and the jagged proximal end of the distal fragment of the radius; the radial bone was absent (Fig. 2). The wound contained sand and fragments of cloth. No major vessels or nerves were severed.

Under nitrous oxide and oxygen anesthesia the skin was scrubbed with green soap and sterile ether and, and cleaned with alcohol and solution of mercuric chloride. All gross debris was removed and the edges of the skin, the devitalized subcutaneous tissue, and muscle were excised. The cavity of the joint was irrigated with warm, normal saline solution. The fragments of the ulna were approximated to one another with two sutures of silver wire and the spicules of the shaft of the radius were removed with rongeur. The end of the bone was placed in contact with the capitulum of the humerus (Fig. 3), and the capsule of the joint was closed with fine silk. The muscles, subcutaneous tissues, and skin were approximated without drainage by interrupted sutures of the same material and the wound was protected with silver foil. The forearm was immobilized in supination with the elbow at right angle by anterior and posterior plaster splints.

Subsequently some posterior angulation of the ulna occurred at the site of fracture and could be corrected only partially. Seven weeks after the accident union was firm both by clinical and fluoroscopic examinations. Active physiotherapy was continued and 5 weeks later the forearm could be flexed to right angle and extended to within 30 degrees of normal, the hand could be rotated to mid-position from full supination. The patient was able to feed herself with the left hand, comb her hair, separate the hand completely and to pronate it by rotating the humerus. Flexion and extension of the rest and fingers were normal. Four and one-half years later flexion of the elbow had improved only slightly; extension at the elbow and pronation of the hand were unchanged (Fig. 4). She was able to do all her own housework and some work about the farm and in the fields.

CASE 3 Hospital No. 7514 J. M. boy aged 6 years, was helping neighbor cut wood with rotary saw when he



Fig 1 Case 1 Male, aged 26 years, lacerated wound of wrist, division of radial and ulnar arteries, median and ulnar nerves, tendons of flexor carpi radialis, palmaris longus, flexors sublimis and profundus digitorum Photographs taken 11 months after injury

lost his balance and fell forward until the dorsal surface of the left forearm came in contact with the whirling blade. Immediately after the accident he was unable to extend or abduct the fingers or to abduct the thumb, dorsiflexion of the wrist was limited. Exploration of the wound under anesthesia disclosed complete division of the extensor carpi ulnaris, extensor communis digitorum, extensor carpi radialis longus, and the abductor pollicis longus; the ulna was divided obliquely and the radius was partially severed (Fig 3), no nerves or major vessels were injured.

The fragments of the ulna were approximated with one suture of silver wire reinforced with a double band of the same material around the shaft (Fig 3). The muscles were sutured with silk and the subcutaneous tissues and skin were closed in layers without drainage. The arm was immobilized in midposition with 90 degrees' flexion at the elbow by molded splints of plaster. Passive motion and

physical therapy were instituted at the end of 3 weeks. Seventeen months after the accident, flexion and extension of the elbow, wrist, and fingers, abduction and adduction of the thumb and fingers, were all normal (Fig 4).

CASE 4 Hospital No 9001 A B, a farmer's daughter, aged 15 years, was helping her father operate a rotary saw when the whirling blade of the machine broke and a flying fragment therefrom struck her in the face and anterior thoracic wall.

She sustained a deep laceration of the right side of the forehead extending into the frontal sinus, superficial abrasions of the upper and lower eyelids, a ragged, lacerated wound of the right cheek extending into the maxillary antrum, division of the right nostril and the end of the nose which was attached only by a small cutaneous pedicle at the junction of the upper lip and septum, lacerations of the upper and lower lips and chin, and a deep, widely gaping



Fig 2 Case 2 Female, aged 36 years, lacerated wound of elbow, compound fractures of radius and ulna, avulsion of radial head. Roentgenograms before and after reduction, photographs 6 years later showing flexion and extension at elbow



Fig 3. Case 3. Male aged 63 years compound fracture of radius and ulna, division of extensor carpi ulnaris, extensor carpi radialis longus, extensor carpi radialis brevis, and abductor pollicis longus. Above, Before reduction; below, after reduction and fixation with a screw.



Fig 4. Case 3. Seventeen months after injury. Flexion and extension at elbow; extension and abduction, flexion and adduction of fingers and thumb, and dorsiflexion at wrist, all normal.

ound of the anterior thoracic wall which extended through the clavicle and down to the upper six costal cartilages (Fig 5).

Under local anesthesia the wounds are carefully debrided and closed in layers without drainage. The clavicle was immobilized with a metal cross. The sutures are removed from the face and nose on the second and third days. Some superficial sloughing occurred about the right nostril farthest from the pedicle (Fig 5).

Two months after the accident a small, edge-shaped defect was present in the skin of the right nostril and the other scars of the face are still red and prominent (Fig 5). Five years later the wounds of the face are scarcely noticeable even at close range but a small defect is still present in the nose and the scars of the thoracic wall are prominent.

CASE 5. Hospital No. 9066. J. S., farmer 37 years old, while operating a bus was struck on the left shoulder by a large, jagged, irregular fragment of burning flywheel, traveling at high speed. He was rendered temporarily unconscious and was in a profound degree of

shock from loss of blood when he reached the hospital hours later. Examination showed a wide, gaping, lacerated

wound of the anterior aspect of the left shoulder and upper portion of the thoracic wall from which exuded and arterial blood, as oozing (Fig 6). All motions of the shoulder and left forearm are extremely painful.

One thousand cubic centimeters of 5 per cent solution of glucose was given intravenously and the patient was grouped and cross-matched. His suitable donor for transfusion. A portable roentgenogram disclosed comminuted fractures of the anatomical and surgical necks of the humerus, compound fractures of the acromion and coracoid processes of the scapula with loose fragment overlying the glenoid fossa, a linear fracture in the wing of the scapula below the glenoid, separation of the acromioclavicular joint (Fig 6), and a stable fracture of the shaft of the radius.

Following transfusion with 500 cubic centimeters of whole blood, the patient's condition improved and he was moved to the operating room. The skin around the wound was shaved, scrubbed with green soap, sterile ether, alcoh-



Fig 5 Case 4 Female, aged 15 years, compound fractures of frontal bone extending into sinus, of superior maxilla extending into maxillary sinus, and of clavicle, lacerated wounds of forehead, eyelids, cheek, nose, lips, chin, and thoracic wall Above, Photographs on admission to hospital, and 3 days later, below, left, face and chest 2 months after injury and face and chest 3 and 5 years later

hol, and a weak solution of bichloride of mercury The wound was gently irrigated with bichloride and the edges were infiltrated with novocain All the devitalized tissues from the sternum to the mid axillary line were cut away and numerous particles of grit and dirt were removed The coracoid process was sutured to the scapula with silver wire Five Dakin tubes were inserted, the edges of the skin were excised, and a sterile dressing was applied The arm was immobilized in abduction at a right angle with a Jones humerus traction splint

The following day the patient had an abrupt elevation in temperature to 105 degrees F and the pulse rate to 136 Examination showed diffuse fullness and tenderness of the thoracic wall below the axilla A moderate amount of sero sanguineous, watery fluid welled up into the wound when pressure was applied over this area and short-chained gram positive streptococci were seen in smears made from this material Counter drainage was established and 10,000 units of antistreptococcus serum prepared by the New York State Laboratory, was administered intramuscularly The following day his clinical condition was somewhat improved and another 10,000 units was given The temperature and pulse rate gradually fell to normal on the tenth day when dakimization was discontinued The large defect slowly filled in with granulation tissue and was later covered with pinch grafts At the end of 7 weeks, traction was discontinued and physical therapy was instituted Clinically and fluoroscopically, the fragments of the humerus were in good position (Fig 6) He was discharged 59 days from the date of the accident

Physical therapy was continued for 6 weeks Two and one half months later the patient was unable to abduct the arm voluntarily beyond an angle of 30 degrees from the plane of the body, passive motion was entirely free and painless in all directions, pronation and supination of the hand were normal Sensory examination revealed an area of anesthesia on the anterior, lateral, and posterior surfaces of the arm corresponding with the distribution of the sensory fibers of the axillary nerve, which also furnishes the entire motor supply to the deltoid muscle It was then obvious that the limitation of active abduction was caused by undetected damage to the axillary nerve at the time of the accident

Five years after the injury the bones were in satisfactory position (Fig 6) A small defect was apparent in the soft tissues of the anterior aspect of the shoulder, the skin was partially adherent to the ribs and intercostal muscles In the supine position the patient was able to abduct the arm normally but when erect could not elevate it beyond an angle of 30 degrees from the vertical plane (Fig 6) In spite of this disability he was able to do all the work on his farm which included pitching hay for 20 cows

CASE 6 Hospital No 11671 A M, a farmer, aged 37 years, sustained a traumatic amputation of the right hand while operating a rotary saw He was unable to recall how the accident occurred but from the nature of the injury it is probable that he fell forward onto the whirling blade Examination disclosed complete division of all the skeletal structures of the wrist from the ulnar side of the carpus transversely across to the radial side The hand was at-



Fig. 6. Case 5. Male aged 37 years: compound comminuted fractures of surgical and anatomical necks of humerus, of 125 and coracoid and acromion processes of scapula, dislocation at acromioclavicular joint, simple fracture of radius, lacerated wound of thoracic wall and shoulder. Above, on admission, after fixation, and 5 years later. Below, on admission and 5 months later.

tached only by badly traumatized tendons and an laceration of skin at the base of the thumb.

Under general anesthesia the wound and surrounding area are thoroughly cleaned. Flap of skin and subcutaneous tissue is reflected from the dorsal surface of the thumb, and the amputation of the hand is completed by dividing the remaining tendons. The radial and ulnar arteries are ligated and the tourniquet as loosened. Several of the carpal bones are removed and all devitalized tissue is excised. The prepared flap is utilized to cover the radial side of the stump, and the four side is partially closed by undercutting and approximating the skin on the dorsal and volar surfaces of the wrist. Gutta percha, sterile gauze and splint are applied.

The immediate convalescence is complicated by an indolent infection of the wound due to *Staphylococcus aureus*. Drainage persisted from several small sinuses for 3 months after which the stump healed and contracted satisfactorily. The skin and subcutaneous tissues are

freely movable on the deeper structures and some motion is present at the radiocarpal joint. The patient learned to write with his left hand and has otherwise adjusted himself so well to the deformity that he can do all the skilled jobs in the routine life of a farmer and does not desire an artificial hand.

SUMMARY

In the care of extensive wounds involving muscles, tendons, nerves, bones, and joints, careful pre-operative observation and treatment, meticulous operative technique and prolonged postoperative supervision are essential in order to secure good functional and anatomical results.

Six cases illustrating wounds of this type due to contact with circular saw have been reported in some detail.

PRESERVED AND FRESH HOMOTRANSPLANTS OF CARTILAGE

JAMES BARRETT BROWN, M D, F A C S, St Louis, Missouri

IN 1928, following reports of the use of boiled bone flaps in neurosurgery, it was thought that cartilage might be preserved or refrigerated so that it could be used at a later date as a subcutaneous prosthesis. A summary of observations made over an 11 year period and illustrations of clinical results are presented here.

Source of preserved homotransplants of cartilage
A constant supply of foreign cartilage is somewhat difficult to maintain. It has been obtained from other patients having autogenous transplants done, and from other operations on the thorax. Autopsies give the easiest and most abundant source, the subject, of course, should be of known age and race, and should not have had any contagious disease. The cartilage should preferably be from a young adult and free of calcification. Cadaver material certainly is not very esthetic, although ear cartilage has been used, somewhat enthusiastically by Kirkham.

From the Department of Surgery, Washington University School of Medicine

Storage or preservative
Alcohol was originally employed as a preservative for simplicity and safety, the cartilage being thoroughly washed in saline before implantation. This method eliminates the necessity of sterile precaution in handling before storing. Other preservatives, refrigeration and freezing may also be used, and freezing might be preferred if a good source of sterile cartilage could be had.

It is preferable to store the cartilage quite clean but it is difficult to strip the perichondrium without damaging the cartilage and, for this reason, it may be best to store it partly clean and then cut the pattern out cleanly at the time of operation.

Zoografts
In the early work, suitable cartilage from other animals was sought, but sheep, cats, and puppies all have bone through the center, and beef cartilage causes too much reaction in the tissues to be retained. The tip of the shoulder blade in beef does offer a very easy source of huge pieces, however, and, if a method of avoiding the



Fig 1 a, left Deformity following autogenous cartilage transplant (done elsewhere) with calcification and distortion of the cartilage, rendering it useless. b, Result of preserved cartilage transplant. Complete mobilization of the lateral bony walls was necessary for narrowing after the distorted cartilage was removed, through and through wires were put in as in Figure 2c, as it is often best not to combine an extension osteo plastic with a fresh cartilage transplant. A preserved cartilage was used as a temporary subcutaneous prosthesis. It was healed promptly, however, and is in good condition more than 2 years later.



b

Fig. 2. a, Depression of cartilaginous dorsum with elevation and disappearance of the columella. b, Complete dorsal, columellar and nasal spine prominence restored in single operation, by mobilization of the bones and implant.

marked reaction to it can be developed the problem of subcutaneous prosthesis will be greatly helped.

Other materials used for implantation. Ivory seems to be satisfactory in many instances and its

use as L-shaped preserved cartilage as shown in Figure 3. c. Through-and-through silver wires fastened over lead plates to maintain narrowness after mobilization of the lateral bony walls.

preparation can be done accurately to pattern, but many of these transplants have given trouble and have been extruded after years. In animals, wood, rubber and celluloid have been retained but have not been satisfactory clinically. Some of the newer plastics and metals such as vitallium may be successful, but a few years' observation will be necessary.

The best possible prosthesis would be one that could be safely injected and molded and would then retain its shape, and because of this ultimate desirability, an injectable suspension of cartilage has been considered, especially for small defects. Paraffin is still thought to be dangerous enough to avoid.

Gross and microscopic appearance of fresh and preserved cartilage. Human costal cartilage appears to be somewhat unique in that its exact counterpart in other easily available animals has not been found. It occurs in two main varieties—white and yellow—and may be calcified in spots or streaks, even in children. Calcification is almost sure to be present in older patients. The white and yellow appearances were formerly thought to be due to a larger number of cells in the white but, after the study of many sections, it is thought that the difference is probably in the hyaline material itself. Preserving the cartilage does not change its microscopic appearance except that the normal cell nucleus is lost and the pathological diagnosis might be made of necrosis because



Fig. 3. Diagram of L-shaped nasal cartilage transplant. a, above. Side view of single piece of cartilage to restore nasal contour with support at the nasal spine and above. This type can be put in holed noses. With only small amount of tissue left in the columella. If the whole cartilage is lost but the mucosa remains, even larger sheet may be used practically to replace the septum. The upper end is always placed under the perosteum if possible and this supports the all regions, if only small pocket of perosteum can be prepared, the best possible support is then obtained. The large piece is best obtained by cutting it out of an angle or here the cartilages are used. b Top view showing breadth above and thinning below to avoid kinking of the tip and columella. If necessary to gain lateral bulk, wide side wings may be left on or extra pieces put in. Both views are diagrammatic. The general shape is cut out and then trimmed down to pattern.

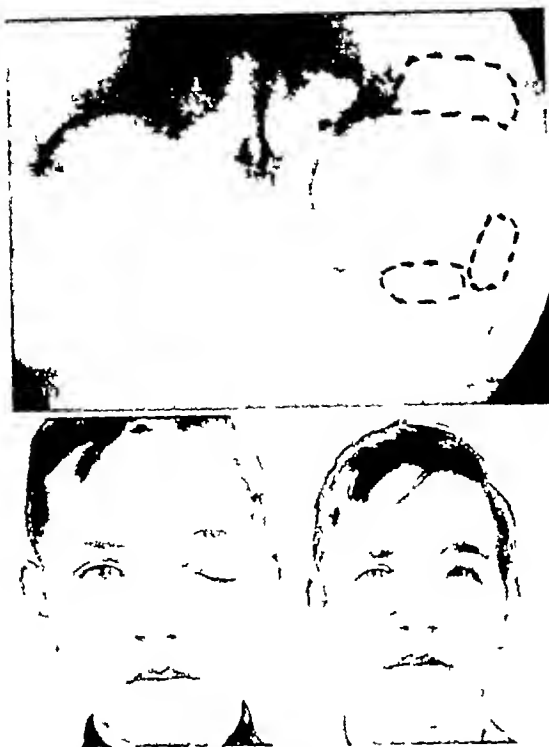


Fig 4 a, above Extreme crushing and loss of bone around the orbital borders, with areas of fresh homografts of cartilage, blocked in, to raise the globe, hold it medially and to form an upper orbital border b, below left Completely ptosed lid over the badly displaced globe c, Result after the three pieces of fresh costal cartilage from the mother were put in place under local anesthesia, and the lid was elevated with fascial transplants Shown after 1 year

of this When preserved in alcohol, the yellow type becomes more yellow, clearer, and harder—sometimes so hard as to be brittle and unsatisfactory for use Curling takes place also but this is thought possibly to be one advantage, that is, to have the curling take place before it is used as a transplant The white cartilage usually stays white and maintains about its original consistency

Fate of preserved cartilage transplants in the tissues There is undoubtedly reaction around these transplants that, in many instances, will result in complete solution of the graft They do not stand any infection well, as a rule, but have healed in satisfactorily following drainage from the wound in several instances The experimental implantation of pieces in animals or in the abdominal wall of patients is not comparable to the clinical use because these beds are, undoubtedly, better than those about the nose and face where the material is usually needed Because of the uniform good



Fig 5 a, left Complete loss of septal cartilage from infection Following an early complete loss, the face doesn't elongate normally in this region and, therefore, it is thought imperative to try to restore the septum if possible Patient seen before marked collapse had occurred b, Result of a single L-shaped piece replacement of the septum with fresh cartilage from the father An extra piece is stored in the epigastrium for possible future use

results, at least of retention of the transplants in soft abdominal wall pockets, it is apparent that the best possible bed should be obtained in the face, and that the wound edges should be closed as thickly as possible

If an especially poor bed is known to be present to receive the transplant it may be of some advantage to store it temporarily in the abdominal wall and use it after it has become firm in its new surroundings

Repeated transplants of the same piece of cartilage have been successfully done, and it is thought that many may remain in the tissues permanently However, as stated, it is definite that absorption takes place to some extent in all instances and complete loss may occur by a gradual process, without visible reaction, over a period of several months This process is not always uniform and the transplant may appear actually scalloped

Clinical evaluation The benefits of preserved over fresh autogenous cartilage may be as follows (1) no operation on chest of patient, (2) a large amount is available, (3) patterns can be made more easily, (4) probably not as apt to curve and distort tissue, (5) may be used as a temporary prosthesis either intentionally or as a necessity The objectionable features are (1) it is not very esthetic, especially if race or color is off, or if there has been some disease in the donor patient, (2) it is not as resistant to infection, (3) it may be completely absorbed without infection, (4) it needs an



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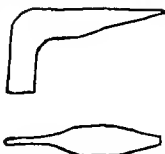


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especially good bed without tension on the wound (5) If it becomes too hard, irregularities cannot easily be trimmed subcutaneously (6) If one falls it is probably best to repeat with fresh cartilage

The patients in Figures 1 and 2 have had preserved cartilage transplants in the nose in place for as long as 3 years. Other areas in which it has been used are the cheeks chin jaw orbit, forehead defects, and in the temporomandibular joint.

At this time the method is not offered as a replacement for fresh homogenous transplants but rather as a second choice substitution when for some reason, the fresh homograft is not advisable. If the cartilage proves to remain only temporarily a fresh transplant may be put in if necessary.

Single piece L-shaped nasal cartilage transplants are used routinely by cutting the pattern out of the angle of the cartilage. This avoids bending the cartilage using two pieces, or making the use of a single piece unsupported at the tip.

It is put in through an incision down the columella (Fig. 3)

Fresh cartilage transplants from other persons In children who do not have large enough costal cartilages to supply good pieces and in any adult who does not want his chest opened—when a fresh cartilage transplant is desired, it is thought that fresh homotransplant may be used with practical certainty of success. The success of cartilage and fascia as free homografts is in contradistinction to skin which is known not to survive permanently (Figs. 4 and 5)

In using homotransplants of cartilage it would be desirable to use a parent or near relative but this is probably not necessary.

Metal pins through cartilage transplants to prevent distortion Any kind of cartilage transplant is apt to curl and cause deformity and observations are being made on the use of a central pin of vitalium to try to maintain alignment of the cartilage.

CARCINOMA OF THE BODY OF THE UTERUS

Experience of the Mayo Clinic for Twenty-Four Years

JAMES C. MASSON, M.D., F.A.C.S., and ROBERT O. GREGG, M.D.,
Rochester, Minnesota

THE clinical characteristics of patients presenting carcinoma of the uterine body have been fairly well established. The great majority of patients fall in the postmenopausal group, as pointed out by Norris and Dunne, 69.5 per cent, Scheffey and Thudum, 52 of 68 patients, and Stacy, 63.3 per cent.

Maternity and trauma of childbearing have little or no influence on carcinoma of the fundus, for Norris and Dunne and others have found a high incidence of nulliparity in patients with this malignant lesion.

Leiomyomas occur very frequently in uteri subject to carcinomatous change. Taylor and Millen found an incidence of 40 per cent of leiomyomas in combination with carcinoma of the fundus, whereas other workers have found them slightly less frequent—Stacy, 37 per cent, Falls, 35 per cent, Norris and Dunne, 34 per cent. Falls found carcinoma occurring in 9.5 per cent of patients operated upon for leiomyomas. We have found no statistical studies concerning the factor of heredity in the genesis of cancer of the fundus.

The possibility that endocrine dysfunction may have some bearing on the genesis of fundal cancer has been suggested by recent studies. The term, endometrial hyperplasia, has been loosely used in the past to designate a non-atrophic endometrium in the postmenopausal uterus. Taylor and Millen found "endometrial hyperplasia" in 15 out of 34 cases of carcinoma of the corpus uteri in which specimens of non-cancerous endometrium were available for study. Of 99 control non-malignant cases in the same age group a non-atrophic endometrium was found in only 11 cases. In 6 of these cases the patients were less than 50 years of age, it occurred in only 5 of them after the age of 50 and in not a single uterus from a woman past 60 years of age. Payne found the incidence of carcinoma in association with postmenopausal hyperplasia to be 10.5 per cent. Novak and Yui found a similar high incidence of "endometrial hyperplasia" in association with cancer of the fundus.

From the Division of Surgery, The Mayo Clinic.

Herrell, in omitting the older "endometrial hyperplasia" from his terminology, and in classifying types of endometrium on the basis of physiological and pathological variations in the menstrual cycle and concomitant hormone changes, has done much to clarify our conception of the endometrium. In 50 cases of carcinoma of the fundus, he found a differentiative endometrium in only 2 cases. Both of these were from women in the premenopausal group. In the 48 remaining cases he found a proliferative type of endometrium, evidence of estrin effect. In 10 patients with fundal cancer he studied the estrin level in the urine and in 8 of these he found 5 or more rat units in a 24 hour sample. These observations suggest that endocrine imbalance may be in some way related to the genesis of fundal cancer, but, until more studies on the incidence of persistent estrin effect postmenopausally have been made, no definite conclusions may be drawn.

The late age of menopause in these cases found by Crossen (3) further suggests a persistent ovarian function as bearing on the causation of fundal cancer.

The characteristic symptoms of fundal cancer have been fairly well established. The most significant symptom is metrorrhagia, which has been reported as occurring in from 80 to 95 per cent of cases. Menorrhagia in patients before the menopause, while more often associated with benign lesions or endocrine disturbance, may occur as the only symptom of a malignant lesion. About one-third of Stacy's patients in the premenopausal group had menorrhagia, and half of the patients in Scheffey and Thudum's series who had not reached the menopause had profuse periods. An abnormal discharge has been found in different series of reported cases in an incidence of 30 to 60 per cent. Pain of the menstrual type has been found in 30 to 40 per cent of patients, but has not indicated necessarily an unfavorable prognosis.

That the lesion is usually of slow development is evidenced by the long duration of symptoms usually reported. Scheffey and Thudum found an average duration of symptoms of 9.5 months.

TABLE II.—AGE AT MENOPAUSE OF PATIENTS WITH CARCINOMA OF THE FUNDUS AND OF A CONTROL GROUP

Age at menopause, years		Total	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	Average age
Carcinoma of fundus	No.	498				11	13	11	41		39.77 years
	Per cent.	100			2	6.6	2.6	2.2	8.4		
Control	No.	20				5	6	6			46 years
	Per cent.	100		7		25	30	30			

5. Loss of weight was not a feature significant loss of 4 pounds or more occurring in only 199 cases, or 27.2 per cent of cases. The average weight loss of this group was 17.6 pounds.

6. Anemia. In 539 cases the concentration of hemoglobin in the blood was determined and of these, 340 cases gave normal values, and 199 were anemic. (Prior to 1919 the Dare hemoglobinometer was used as standard and 70 per cent or less was considered as indicative of anemia. Since 1919 the Cenco-Shepard-Sanford photometer has been used. Since that time any hemoglobin level less than 12 grams per 100 cubic centimeters has been considered as indicative of anemia.)

PATHOLOGY OF CARCINOMA OF THE BODY OF THE UTERUS

Grade and extent of lesions. There were 357 cases in which the patient was primarily treated here and in which the histological grade was determined according to the method of Broders on a basis of 1 to 4. Of these 57 cases were classified in grade 1, 134 cases were in grade 2, 31 cases were in grade 3, and 35 cases were in grade 4.

In 467 cases it was possible to classify the growths as to extent of lesion. In 265 cases this was not possible. In the unclassified group we have included all cases in which the patient was treated by radiation and in which clinically a stage 4 growth had not been reached, as well as cases in which operation had been performed. Our system of grouping according to stage corresponds fairly closely to that of Schmitz and Schmitz except that in stages 2 and 3 we have included

only cases in which operation had been performed, whereas their classification is entirely a clinical one.

In stage 1 we have included only those cases in which the growth was limited to the endometrium. In stage 2 we have included all those cases in which the muscle was invaded, but in which the peritoneal coat had not been reached. Included in this group are several cases in which the growth had extended into the upper portion of the cervix but in which the origin was clearly in the fundus. We have placed all cases in which both fundus and cervix were involved and in which there was a question as to origin in a separate group, carcinoma of fundus and cervix. In stage 3 we have placed those cases in which the carcinoma had extended to the peritoneum with or without attachment to adjacent structures, as long as other structures were not grossly invaded by malignant tissue. In stage 4 we have placed all cases in which any structure outside the uterus itself was involved. This includes parametrium, tubes, ovaries, bladder, bowel, other contiguous structures, lymph nodes and distant metastases. In some cases in which both ovary and fundus were involved in the malignant process it was impossible to tell which was the primary site or whether we were dealing with two primary tumors. If the lesion was apparently primary in the uterus with secondary ovarian involvement the case was classified in stage 4, unless the cell characteristics of the two tumors were sufficiently

TABLE IV.—PERCENTAGE DISTRIBUTION OF DURATION OF METRORRHAGIA BY EXTENT OF LESION

Stage	No. metrorrhagias	Duration of metrorrhagia				
		0-6 months	7-12 months	13-24 months	25-36 months	36 months plus
1	18	44				
		15	11			
		26	26.8	26		
4	22.2	24.8	44	1.6	2.2	2

TABLE III.—PERCENTAGE AGE DISTRIBUTION BY EXTENT OF LESION

Stage	Age in years				
	20-24	25-29	30-39	40-49	50-59
1		26	26		
				23	
		16	17	15	
4	1	22.9	29.4	26.4	2.0

TABLE V—SYMPTOMS OF CARCINOMA OF FUNDUS ACCORDING TO GRADE OF MALIGNANCY*

Grade	No cases	Pre-menopausal	Menorrhagia		Metrorrhagia			Discharge		Anemia			Weight loss		Pain	
			No	Per cent of pre-menopausal cases	No	Duration, months	Per cent	No	Per cent	Anemic	Not anemic	Per cent anemic	No	Per cent	No	Per cent
1	57	23	15	65.2	48	0-12	22	34	59.6	15	34	30.6	11	19.2	16	28.1
						13+	26									
2	134	32	16	50.0	15	0-12	80	101	75.4	30	83	26.5	33	24.6	32	23.9
						13+	45									
3	31	7	4	57.1	23	0-12	13	17	54.8	9	19	32.1	4	12.9	5	16.1
						13+	10									
4	35	6	3	50.0	28	0-12	21	28	80.0	8	19	29.6	15	42.8	8	22.8
						13+	7									

*All recurrent cases are excluded from this table.

different to justify a diagnosis of two primary malignant lesions

Using the criteria just mentioned, we found in our series the cases falling into the separate stages as follows: stage 1, 89 cases, stage 2, 217 cases, stage 3, 77 cases, stage 4, 84 cases, and 265 unclassified

Incidence of leiomyomas Leiomyomas occurred in 215, or 36.4 per cent, of 590 cases in which operation was performed. There was no significant difference in percentage of leiomyomas in the less or more extensive lesions

Relation of age to extent of lesion This is shown briefly in Table III. It can be seen that of stage 1 growths 37 per cent occurred in patients less than 50 years of age, of stage 2, 18.7 per cent, of stage 3, 19.5 per cent, and of stage 4, 24.2 per cent

Relation of duration of metrorrhagia to extent of lesion Since metrorrhagia is the most significant symptom of carcinoma of the fundus we have used it to designate roughly the duration of symptoms for the successive stages of growth. This is shown in Table IV

It can be seen that 64.1 per cent of the stage 1 group had either no metrorrhagia or it lasted less than 6 months, and only 24.6 per cent of patients had had this symptom more than 1 year. In the stage 2 group 48 per cent of patients had had no metrorrhagia or it had lasted less than 6 months, whereas 33.2 per cent had had this symptom more than 1 year. In the more advanced lesions the percentage of patients having symptoms for longer periods increases somewhat, although not greatly. Thus stage 3 growths were found with symptoms lasting more than 1 year in 45.5 per cent of cases, and of the stage 4

growths 38.0 per cent had symptoms more than 1 year

Relation of anemia to extent of lesion Thirty-eight and five-tenths per cent of patients with stage 1 lesions were anemic, 27 per cent of those with stage 2 lesions, 38.8 per cent of those with stage 3 lesions, and 45 per cent of those with stage 4 lesions

Relation of anemia to leiomyomas Among patients on whom operation was performed and for whom the level of the blood hemoglobin was determined 30.2 per cent of those with leiomyomas were found to be anemic, whereas only 18.3 per cent of the patients without leiomyomas were found to be anemic

Relation of menorrhagia to leiomyomas Of 205 patients in the premenopausal group on whom operation was performed, 105 had menorrhagia and of these 52 had leiomyomas. Thirty-eight out of 90 patients with leiomyomas did not have menorrhagia, and 53 of 115 patients without leiomyomas had menorrhagia

Relation of symptoms to grade of malignancy Table V shows that (1) grade 1 of malignancy occurs more commonly before the menopause than do the higher grades, (2) metrorrhagia occurred in 91 per cent of grades 1 and 2, but in only 78.3 per cent of grades 3 and 4, (3) weight loss occurred about twice as frequently in grade 4 lesions as in any other group, and (4) there was no significant difference in the incidence of discharge, anemia, or pain in the lower and higher grades of malignancy. Actually pain occurred slightly more often in patients with grade 1 malignancy than in patients with any of the other grades of malignancy

TABLE VI—THE OPERATIVE MORTALITY AND FIVE AND TEN YEAR SURVIVALS ACCORDING TO STAGE OF GROWTH OF CARCINOMA OF THE BODY OF THE UTERUS

	Patients operated on up to December 31, 1928						Patients operated on up to December 31, 1933			
	No. cases	Hospital mortality	Per cent	No. traced	Alive 5 yrs	Per cent	No. cases	No. traced	Alive 5 yrs	Per cent
Stage	54		49	86	7		74		57	76
Stage			5.53	10	36		129	121	79	61
Stage 1	77	6	7.79	76	44	57	57	36		39
Stage 2, operated on	49		26	49		11	38	38		36
Stage 2, irradiated	35			33		5.5	27	27		4.6
Mixed, operated on	37	18	6	33	64		140	136	7	57
Radiation alone	67			67	27	47.8	44	44		77.3
Radiation, on tumor	27			1		34	31	36		39
Total	728	25	3	77	423	54.2	577	526	253	43.5

January 21 of January 1910

(This group was largely considered clinically not second hospital cases, and on histological diagnosis was established.)

TABLE VII—FIVE YEAR SURVIVALS AND DISTRIBUTION BY GRADE OF MALIGNANCY OF LESION. PATIENTS TREATED BY RADIATION ALONE AND BY OPERATION WITH OR WITHOUT RADIATION

Treatment	No. cases traced	Survival per cent	Per cent survival	Per cent of graded cases				Average age, years
				Cure	Grade	Grade	Grade	
Radiation alone	43	53	39	39	31	14	14	
Operation with or without radiation	57	57.9	72	26.6	75.0	39.7	7.7	51.1

SURVIVAL

Carcinoma of the body of the uterus. A total of 732 patients suffering from carcinoma arising primarily in the fundus of the uterus was seen at the Mayo Clinic from January 1, 1910, to December 31, 1933 inclusive. Seven hundred twenty-eight of this group were treated, 4 untreated. Five hundred eighty-nine had surgical procedures (with or without irradiation) calculated to remove all or part of the tumor 139 had some form of radiation exclusively (Table VI).

The hospital mortality for the entire group was 3.8 with 37 following operative procedures, following radium therapy. In Figure we have graphed the causes, 1 death and the type of procedure in each case. Fourteen deaths were attributed to peritonitis, 12 to pulmonary emboli. Twenty-eight followed total abdominal hysterectomy, 6 followed subtotal abdominal hysterectomy and 3 followed vaginal hysterectomy. The 1 death in the cases in which irradiation only was used was attributed to coronary occlusion.

The group of 67 cases in which radiation was used alone was made up of cases locally operable and of questionable operability. We have selected

43 cases from this group in which on examination the growth was freely movable, but because of some complicating factor irradiation was employed instead of operative procedures.

In Table VII we have shown the percentage of the various grades in this group treated by irradiation and in the operative groups (including stages 1 and 2 and the 5 year survival).

According to United States life tables, Bureau of the Census, for the years 1929 to 1931 at age 63 the expected mortality in the following 5 years for white females is 14.8 per cent. At age 63.4 in our series of irradiated patients we found 40.5 per cent dead in the next 5 years. Subtracting the 14.8 per cent death expectancy we found 25.7 per cent dead owing probably to carcinoma of the fundus. At age 55, the average age of our patients on whom operation was performed according to the United States life tables only 8.1 per cent of white women are expected to die in the following 5 years from all causes. Subtracting this figure from our 26.9 per cent dead in the group of patients upon whom operation was performed we find 18.8 per cent probably dead of cancer.

TABLE VIII—FIVE YEAR SURVIVALS ACCORDING TO GRADE OF MALIGNANCY AND STAGE OF GROWTH PATIENTS PRIMARILY TREATED AT THE CLINIC

	Grade 1		Grade 2		Grade 3		Grade 4		Totals		Indeterminate		Per cent alive*
	Traced	Alive	Traced	Alive	Traced	Alive	Traced	Alive	Traced	Alive	Traced	Alive	
Stage 1	15	13	6	6	1	1	1	1	23	21	61	51	83.7
Stage 2	29	24	71	50	8	8	7	6	115	88	95	68	74.3
Stage 3	1	1	16	8	9	5	5	2	31	16	45	25	57.9
Stage 4 operated on	5	2	6	2	6	2	7	0	24	6	25	6	24.5
Stage 4 radiation	0	0	1	0	0	0	5	1	6	1	29	2	8.6
Indeterminate operated on	2	1	15	10	1	0	3	2	21	13	13	81	61.4
Indeterminate radiation	5	3	19	9	6	3	3	1	33	16	69	28	43.1
Total	57	44	134	85	31	10	31	13	253	161	458	264	
Per cent alive 5 years	77.2		63.4		61.3		41.0		63.6		57.6		

Total average 5 year cure—711 traced cases—60.1 per cent alive.

*Graded + indeterminate

Although the irradiated group is small, as far as could be determined the 2 groups were both technically operable, and afford as fair a basis of comparison as we were able to get. Probably the death expectancy in the irradiated group is higher than given in the United States life tables since operation was deemed inadvisable because of poor general condition.

In Table VIII we have grouped the survival rates for all traced patients whose lesions were graded and divided into the 4 clinical stages.

There was 1 hospital death in the stage 1, grade 1 group, leaving of the stage 1 graded patients who survived operation only 1 patient dying within the 5 year period.

In Figure 3, we have graphed the percentage of 5 year salvage of all patients traced for whom grading of the tumor was performed and for whom the stage of growth was determined. It can be seen that an early growth implies a slightly better prognosis than a low-grade growth, and that a very extensive growth indicates a graver prognosis than does the grade of the tumor alone.

Carcinoma of fundus and cervix. There were 22 patients with malignant lesions in the group, carcinoma of cervix and fundus. Of these, 6 were living 5 or more years and 4 of 21 traced were living 10 years after radiation or operation. Operative procedures, with or without irradiation, were performed on 12, some form of radiation alone was administered to the 10 remaining.

Carcinoma of fundus and ovary. Eighteen patients had carcinoma of both uterus and ovary in which the primary site was not definite or in

which the possibility of two primary tumors could not be excluded. Sixteen were treated by operative procedures, 2 were treated with radiation alone. Thirteen of the patients on whom operation was performed were alive 5 years after the operation and of 11 patients on whom operation was performed and who were traced 10 years, 7 were alive at the end of that period. Seven of these 18 patients had low grade papillary cystadenoma or grade 1 carcinoma. One of 2 patients treated with irradiation survived 5 years.

The single patient with a fibrosarcoma of the ovary complicating a fundal malignant lesion was alive 6 years following total abdominal hysterectomy with bilateral salpingo-oophorectomy.

Recurrent carcinoma following treatment elsewhere. Forty-seven patients had had previous operation or radiation before coming to the clinic. Eight lived 5 years or more after treatment here. Of these 8 surviving patients, only 1 patient had definite tissue diagnosis of carcinoma here. Five patients lived more than 10 years, but in not 1 of these was a definite tissue diagnosis established. One patient came with a large fecal fistula following irradiation and was thought to have a large recurrent pelvic cancer, but lived 9 years and finally died of intestinal obstruction. Two other patients died of carcinoma at the end of 5 and 7 years, respectively.

Total group of probable carcinoma of the fundus. Adding these latter groups to our primarily treated series we have 799 patients treated and traced at the clinic for probable carcinoma of the fundus of the uterus with a 5 year salvage of 455

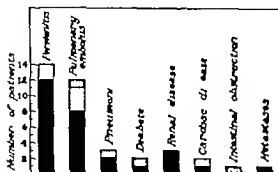


Fig. 3. Frequency of deaths in hospital following surgical and/or radiological treatment for carcinoma of the fundus of the uterus, by cause of death and type of treatment. Black areas, total abdominal hysterectomy; oblique lined area, subtotal abdominal hysterectomy; crosshatched area, vaginal hysterectomy; dotted area, dilatation and curettage and radium.

patients, or 56.9 per cent. Omitting the 47 recurrent cases we find a total of 752 traced primary cases with 447 surviving for a 5 year salvage of 59.4 per cent.

The influence of leiomyomas on prognosis We have traced 310 of 315 patients on whom operation was performed and who had leiomyomas complicating carcinoma of the fundus. Table IX shows the 5 and 10 year survivals for the entire group and for the several stages. These percentages compare quite similarly with all cases of carcinoma of the fundus with and without fibroids (Fig. 3).

Sarcoma of the uterus For comparison we have shown the relative numbers of sarcoma and carcinoma seen at the clinic in the same period together with the 5 year salvage of sarcoma.

TABLE IX.—FIVE AND TEN YEAR SURVIVALS BY STAGE FOR PATIENTS ON WHOM OPERATION WAS PERFORMED AND WHO HAD LEIOMYOMAS COMPLICATING CARCINOMA OF THE FUNDUS

Stage	5 years				10 years			
	No. cases	Treated	Alive	Per cent	Treated	Alive	Per cent	
Stage I	35	35	26	64	29	21	79.4	
Stage II	79	76	54	71	53	33	62.3	
Stage III	84	84		96.9	81		33	
Stage IV	17	17		96.4	15			
Unclassified	60	63	37	62	55	27	49	
Totals	255	300	208	69	173	77	45	

In Figure 4 we have shown the numerical incidence of sarcoma and carcinoma of the fundus by decades. Below the age of 40 years they are of about equal occurrence from 40 to 49 carcinoma is about 3.5 times as frequent from 50 to 59 about 17 times as frequent and from 60 to 69 about 18 times as frequent. Sarcoma did not occur in this series past the age of 70. The ratio of occurrence of carcinoma to sarcoma was 8.8:1.

The 5 year survivals of sarcoma of the uterus according to stage of growth are given in Table X.

Three patients had both adenocarcinoma and sarcoma. In each of these patients the growths had not extended to the serosa and all were living at the end of 5 years. One died after 9 years, cause unknown the 2 others were living at the last report 6 and 9 years, respectively after operation.

EVALUATION

The age of our group approximates that reported by others, as does the marital state and incidence of sterility. About 5 patients were postmenopausal to 3 premenopausal. We were unable to confirm the observation reported by Crossen (4) that menstruation persists longer in women in whom carcinoma of the fundus develops.

The relatively long duration of symptoms before the appearance of the patient for treatment suggests that the malignant lesion is of slow growth or that symptoms are due to other precancerous lesions or associated pathological conditions. The group with fibroids showed no significant difference in menorrhagia, pain, metrorrhagia, or weight loss from those without fibroids but did show a higher percentage of patients with anemia.

A somewhat higher percentage of stage 1 growths was found below the age of 50 years than of the more advanced lesions. That the stage of growth was somewhat indicated by the duration of symptoms is shown in the table for duration of menorrhagia by stages. In stage 1 growths 64 per cent had had symptoms less than 6 months, whereas in stage 4 growths only 36.9 per cent had had symptoms less than 6 months.

In evaluation of prognosis we have used both the histological grade and extent of lesion. The higher the grade of lesion the more likely it is to be extensive when first seen. Menorrhagia occurred in about 90 per cent of the grade 1 and 2 cases, and in less than 80 per cent of grade 3 and 4 cases. In all other symptoms there was no significant difference according to grade or extent of lesion.

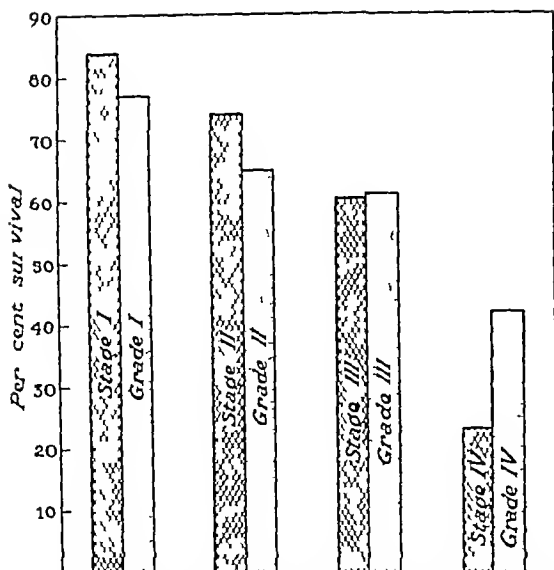


Fig 3 Comparison of 5 year survival of patients suffering from carcinoma of the body of the uterus according to extent of lesion with survival according to grade of malignancy of lesion

The operative mortality for cancer of the fundus is about four times that for benign lesions. The mortality rises progressively with the extent of the lesion. Many of the deaths occurred in extensive cancer, but in this group a small percentage lived many years, apparently cured of their malignant lesion. Nearly one-third of the deaths were due to pulmonary emboli.

The gross 5 year survival of the primarily treated group of 59.7 per cent means, deducting 7.5 per cent who would be dead within 5 years after the age of 56 years according to the United States life tables, that approximately 32.8 per cent died of cancer the next 5 years.

The number of patients treated by irradiation alone at the clinic is too small to offer a satisfactory basis of comparison with the results of operation. The 42 cases in which irradiation was used but which were technically operable we have compared with the cases in which operation was performed and in which the malignant lesion had not extended beyond the uterus. This, it seems, is as nearly accurate a basis of comparison as we could get in our series. Heyman, at the Radiumhemmet in Stockholm, has pointed out many of the difficulties in accurately applying radium to fundal cancer. Accurate dosage of roentgen therapy in the very obese is impossible. Phœneuf has calculated that the minimum lethal dose for corpus carcinoma is from 5 to 10 skin

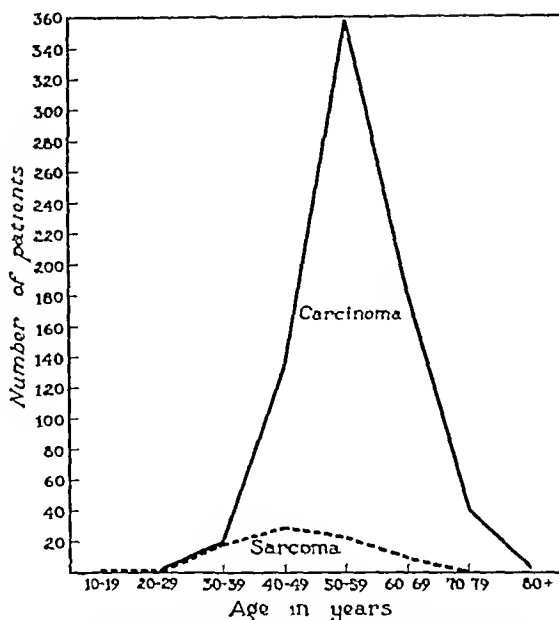


Fig 4 Distribution by age of patients suffering from carcinoma and from sarcoma of the uterus seen at the Mayo Clinic from January 1, 1910, to December 31, 1932, inclusive

erythema units, and that the difficulties of uniform dosage are great. On theoretic grounds alone surgical treatment appears the method of choice in patients with good operative risk. Whether pre-operative irradiation combined with operation gives better results than operation alone will require many years to prove in institutions where large numbers of corpus cancers are treated. In our series the difference in the 5 and 10 year cure after operation with and without irradiation is too small to be of significance.

Whether the stage or grade of growth gives a more accurate estimate of prognosis can hardly be

TABLE V — FIVE YEAR SURVIVALS BY STAGE FOR PATIENTS SUFFERING FROM SARCOMA OF THE UTERUS

	No. cases	Traced 5 years	Living 5 years or more	Per cent of traced cases living 5 years or more
Stage 1	11	11	7	63.6
Stage 2	43	43	32	74.4
Stage 3	16	14	3	21.4
Stage 4	10	10	2	20.0
Unclassified	4	4	1	25.0
Total	84	82	45	54.9

definitely stated from our series. Of the patients with stage carcinoma, 83.7 per cent were alive 5 years later, regardless of grade, whereas of the patients with grade 1 carcinoma 77.3 per cent were alive 5 years later. In comparing grade 3 malignant lesions with those of stage 3 the prognoses in the stage 3 growths is slightly better than in the grade 2 growths. In the higher grades and more extensive lesions, the higher grade did not give quite as serious a prognosis as the more extensive growth. Significant, however, is the fact that of the stage 4 grade 4 cases in which operation was performed not a single patient was alive 5 years later.

SUMMARY

The histories of 907 patients suffering from malignant lesions of the body of the uterus seen at the Mayo Clinic from January 1, 1910, to December 31, 1933 inclusive, have been reviewed. Eight hundred eighty were treated and traced 5 years or more. Seven hundred thirty-two patients were seen primarily at the clinic with definite carcinoma of the body of the uterus 728 were treated. In 23 additional cases there was carcinoma of the body and cervix in 18 more there was carcinoma of the body of the uterus and of the ovary and in 1 there was carcinoma of the body of the uterus and a fibrosarcoma of the ovary. Forty-seven patients suffering from recurrent carcinoma after treatment elsewhere were seen at the clinic. Three cases of carcinoma and fibrosarcoma in the same specimen were found in the same period. Eighty-four patients suffering from sarcoma were seen in the same period 82 of whom were traced 5 years or more. An analysis of 733 cases of primary carcinoma of the fundus has been presented in detail.

1 The average age was 56.1 years.

2 Seventy-three patients were single 659 were married. The average number of children per married woman was 2.31.

3 Two hundred twenty-one patients were premenopausal, 50 postmenopausal. The average age at menopause of the postmenopausal group was 50.27 years, that of control group 49.9 years.

4 *Symptomatology* (a) Metrorrhagia was complained of by 660 patients, or 60.3 per cent. Its average duration was 8 months. (b) An abnormal discharge was complained of by 503 patients, or 63.6 per cent. On the average it had persisted 6.4 months. (c) Menorrhagia occurred in 119, or 56.1 per cent of 3 premenopausal patients. It had lasted 49.6 months on the average. (d) Pain occurred in 204 patients, or

27.9 per cent, persisting on the average for 13.2 months. (e) Weight loss occurred in 199 patients, or 27.3 per cent. (f) Of 539 cases in which the level of blood hemoglobin was determined, 199 were anemic.

5 *Lefromyomas* of the uterus were associated with carcinoma of the fundus in 215 of 590 cases in which operation was performed, or an incidence of 36.4 per cent.

6 Of 257 cases in which the histological grade was determined 57 were graded 1, 134 graded 2, 31 graded 3 and 35 graded 4.

7 In 467 cases in which it was possible to classify as to stage of growth there were 89 stage 1, 217 stage 2, 77 stage 3 and 84 stage 4.

8 *Relation of symptoms to extent of lesion.* Stage 1 patients showed metrorrhagia for less than 6 months in 64 per cent of cases, whereas stage 4 presented metrorrhagia of 6 months or less duration in only 36.9 per cent of cases.

9 *Relation of symptoms to grade of lesion.* (a) Only 59.6 per cent of grade 1 lesions were postmenopausal, whereas 82.9 per cent of grade 4 lesions occurred in the postmenopausal group. (b) Ninety-one per cent of grade 1 and grade 2 malignant lesions showed metrorrhagia whereas only 77.3 per cent of grade 3 and 4 carcinomas showed metrorrhagia. (c) Weight loss occurred more frequently in grade 4 lesions than in lesions graded 1, 2 or 3. (d) There was no significant difference in different grades as to discharge, anemia, or pain.

10 *Survival.* (a) The hospital mortality for all treated patients suffering from pure carcinoma of the fundus was 38 or 5.22 per cent. Fourteen deaths were due to peritonitis and 12 to pulmonary emboli. (b) The 5 year survival of 711 traced patients suffering from distinct carcinoma of the fundus was 42.5 cases, or 59.8 per cent. The 10 year survival of 520 traced patients was 257 or 49.5 per cent. The 5 year survival of all patients having carcinoma of the fundus including those with carcinoma of cervix and ovary was 56.9 per cent. Omitting the recurrent cases, the 5 year salvage was 59.4 per cent. (c) The 5 year survival of 86 traced stage 1 patients was 72 or 83.7 per cent of 210 traced stage 2 patients, 74.3 per cent, of 76 traced stage 3 patients 60.3 per cent and of 49 traced stage 4 patients on whom operation was performed, 24.5 per cent. (d) The 5 year survival of 57 grade 1 traced patients was 77.3 per cent of 34 grade 2 patients, 64.9 per cent of 31 grade 3 patients, 61.3 per cent, and of 31 grade 4 patients, 4.2 per cent. (e) Six of 22 patients with carcinoma of the body and also of the cervix lived 5 years after treat-

ment (f) Of 47 patients with recurrent pelvic carcinoma, probably arising in the body of the uterus, 8 were living 5 years after treatment at the Mayo Clinic

11 Forty-two patients whose lesions were technically operable but who were irradiated alone because of their poor general condition gave a 5 year salvage of 25, or 50.5 per cent, whereas the 5 year survival of all patients with stage 1, 2, or 3 growths on whom operation was performed was 73.1 per cent. The average age of the irradiated group, however, was 63.4 years, whereas the average age of the group operated upon was 55.5 years

12 The occurrence of leiomyoma with carcinoma had little influence on the symptoms or prognosis in fundal carcinoma. Anemia was the single factor more common in patients with leiomyoma than in the rest of the group

13 Eighty-four patients with sarcoma of the uterus were primarily treated at the Mayo Clinic in this period. Eighty-two of this group were traced 5 years. Of them 45, or 54.9 per cent, were living at the end of this period. The hospital mortality was 2 cases, or 2.4 per cent

14 In 3 cases there were both sarcoma and carcinoma in the same specimen. Each case was in the stage 2 classification, and each patient lived more than 5 years

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THE TECHNIQUE OF COMBINED DIVISION LIGATION AND INJECTION OF THE INCOMPETENT GREAT SAPHENOUS VEIN

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THE ligation of varicose veins is not a new practice nor is ligation of the great saphenous vein with injection of its distal portion a new practice. It has been only within the past few years, however, that therapy for varicose veins has been considered satisfactory. This is largely due to improvement of the sclerosing solutions used and better understanding of the principles of ligation. At present, ligation of the great saphenous vein at the saphenofemoral junction, with separate division and ligation of its highest tributaries, together with excision of a small segment of the main trunk distal to the ligature is considered an essential part of treatment for varicosities in which incompetency of the saphenous system can be demonstrated.

This method has reduced to a minimum the remote danger of embolism. It has increased the ease of subsequent sclerodosis due to reduction of gravitational venous pressure. The number of subsequent injections necessary to obliterate completely the incompetent system has been reduced. The chief advantage has been the marked reduction in the incidence of recurrence by elimination of recanalizing infarcts of the gravitational pressure by separate division and ligation of all tributaries which might form collateral circulation and by care to eliminate a blind stump of saphenous vein which might become elongated.

The importance of these points can be better understood by briefly reviewing the anatomy of the great saphenous vein in the region of the fossa ovalis (Fig. 1). The great saphenous vein ends in the femoral vein at the fossa ovalis. Just distal to its junction with the femoral vein there are three comparatively constant tributaries, the superficial circumflex iliac, the superficial epigastric, and the superficial external pudendal veins. These veins, in a few instances, may join directly the femoral vein. At a slightly more distal level two comparatively inconstant tributaries, the lateral and medial superficial femoral veins, join the

great saphenous vein. As a rule however these are not visualized in the course of dissection of the great saphenous vein at the fossa ovalis. In approximately 50 per cent of cases in which surgical treatment is employed a large incompetent vein joins the great saphenous vein at or just distal to the fossa ovalis. This large incompetent vein joins the lateral or anterior aspect of the saphenous vein, lies almost parallel but slightly lateral to the saphenous vein, and is frequently dilated to a size equal to or larger than the great saphenous vein, thus, it can easily be mistaken for the latter. We have called this vessel the accessory saphenous vein, but it is highly probable that this is an incompetent lateral superficial femoral vein that joins the saphenous vein at a level more proximal than is usual (Fig. 1). Its presence can be suspected when a group of varicosities is seen on the lateral or anterior aspect of the thigh. Occasionally an incompetent medial superficial vein may join the saphenous vein on its anterior or medial aspect at or just distal to the fossa ovalis. When either of these superficial femoral veins is present at this site it should be dealt with in the same fashion as any other tributary of the great saphenous. In addition sclerosing solution should be injected into the distal portion.

Our method of combined division ligation, and injection of the great saphenous vein is similar in many details, to that proposed by others. Prior to operation, the deep venous circulation is proved adequate the patient is tested for sensitivity to the sclerosing solution to be employed, and the degree of incompetency of the saphenous vein is determined. Early in our work we were careful to locate and mark the saphenous vein at the fossa ovalis prior to operation. This was done with the patient standing and by palpating the impulses set in motion along the course of the vein by percussion. When the patient is placed in a supine position with the leg slightly rotated externally this marking is no longer accurate. Therefore, we have found it more satisfactory to determine the site of the fossa ovalis after the patient has been placed on the operating table and

From the Section on Postoperative Care, The Mayo Clinic.

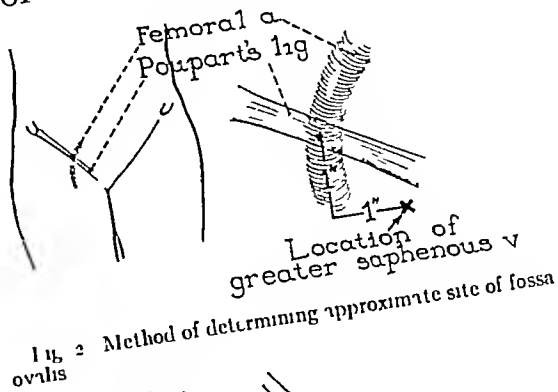
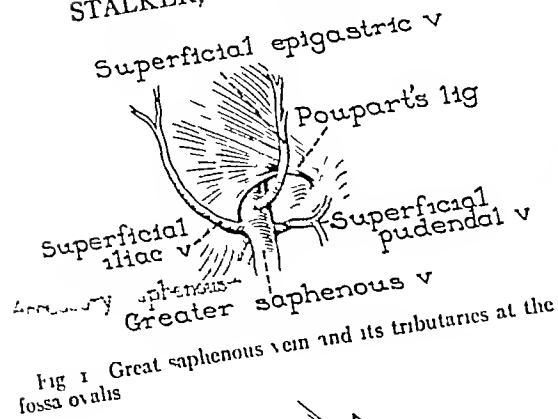


Fig 2 Method of determining approximate site of fossa ovalis

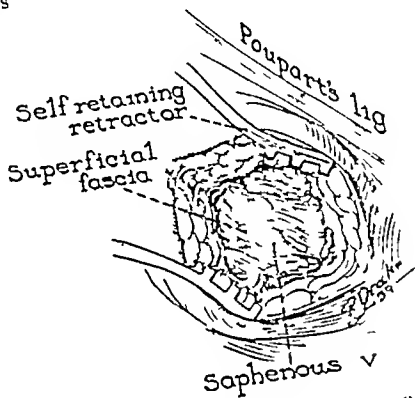


Fig 3 Incision down to superficial fascia and insertion of self retaining retractor

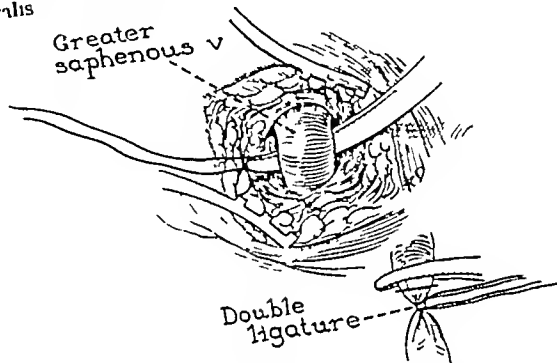


Fig 4 Great saphenous vein freed from its bed, double ligation of distal portion and site of division of vein are illustrated

draped for operation. The maximal pulsation of the femoral artery is located at the lower border of Poupart's ligament, by measuring downward approximately 1 inch and then medially approximately 1 inch the saphenous vein has been located satisfactorily at the fossa ovalis in the majority of instances (Fig 2). A scratch mark is made on the skin at this site. When the vein is large enough, it can be palpated at this site, if the patient produces an increase of intra-abdominal pressure by coughing or straining.

The line of incision and the region immediately above and below are infiltrated with a 1 per cent solution of procaine. Inasmuch as the nerve supply to this field is derived mainly from the outer side, the injection is made first in this region. An ample incision is made parallel to Poupart's ligament, using the marked site of the fossa ovalis as its center. The incision is carried down to the superficial fascia and a self-retaining mastoid type of retractor is inserted (Fig 3). The operation is greatly facilitated by this permanent and steady form of retraction which does not distort the landmarks. Other additional retraction, when

necessary, is obtained by the use of small curved ribbon retractors.

The superficial fascia, which is a continuation of the abdominal Scarpa's fascia, is usually seen as a well defined layer. This definition describes the superficial fascia most characteristic of thin, muscular people, it may be thinned out in obese patients. The great saphenous vein lies beneath this fascia and superficial to the fascia lata of the thigh. This vein frequently can be seen through the superficial fascia which is now picked up and incised in the same direction as the incision. If the vein is not readily visible, it usually may be exposed by blunt dissection by means of a finger covered with a piece of dry gauze to aid in pushing the fat to one side or to the other. The vein is then separated from its bed for a short distance and the curved clamp is passed beneath it (Fig 4). It is doubly ligated with chromic catgut and a curved clamp is placed on it just proximal to the double ties. The vein is divided between the clamp and ties and the distal portion is allowed to retract downward, being held available by one of the sutures, which has been left long for this purpose.

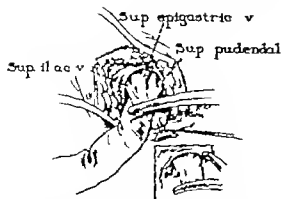


Fig. 5. Dissection of the saphenous vein proximally toward the femoral vein, exposure with separate division and ligation of uppermost tributaries.

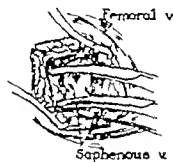


Fig. 6. Clamping of stump of the great saphenous vein at the saphenofemoral junction.

Inasmuch as all of the three uppermost tributaries of the great saphenous vein enter either on the anterior or lateral aspects of the vein it is now possible to insert the index finger posterior to the proximal stump and carefully strip away the loose areolar tissue that surrounds it, thus exposing it proximally as far as the femoral vein (Fig. 5). This facilitates exposure of the superficial iliac, epigastric, and pudendal tributaries which are divided and ligated separately and leaves the proximal stump of the great saphenous vein free of any tributaries. Occasionally the external pudendal artery passes anterior to the saphenous vein and may be divided in order to expose satisfactorily the femoral vein.

By traction on the proximal stump of the saphenous vein the anterior surface of the femoral vein is exposed and two curved clamps are placed at the saphenofemoral junction (Fig. 6). The great saphenous vein is then doubly tied with chromic catgut sutures just proximal to these clamps. A small stump of vein is left just distal

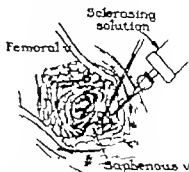


Fig. 7. Ligation at saphenofemoral junction. Injection of sclerosing solution into distal portion of vein.

to the second tie and the remainder usually 3 to 4 centimeters in length, is excised. We have not found it necessary to transfuse this doubly ligated stump.

The distal portion of the vein is now pulled into the wound and the sclerosing solution is injected directly into the lumen of the vein (Fig. 7). A needle of small gauge is used so that when tension on the vein is released, the opening in the wall is closed and there is no leakage of sclerosing solution into the surrounding tissues. The wound is irrigated with saline solution and the patient is asked to strain, in order to detect evidence of bleeding. The superficial fascia is approximated by means of two or three interrupted sutures of plain catgut and the skin is closed with interrupted dermal sutures. The patient is allowed to walk to help distribute the sclerosing solution throughout the venous channels, but he is detained in the hospital for a period of 30 minutes or more to observe any untoward reaction that might occur. The patient is allowed to return to his home and to report to the clinic on subsequent days until obliteration of the veins of the lower extremity is completed. None of these patients has experienced serious reaction following this operative procedure.

It has been our experience that recurrences are dependent, to a great extent, on the thoroughness with which this operation is done. The chances of cure are in direct proportion to the thoroughness and care with which resection of the saphenous veins, together with careful ligation of all communicating branches, is performed. We feel that ligation of the great saphenous vein, with separate division and ligation of its most proximal tributaries, is an essential part of treatment for varicoidities in which incompetency of the main saphenous trunk can be demonstrated.

SIMPLE NON-SPECIFIC ULCER OF THE JEJUNO-ILEUM

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A SIMPLE ulcer of the small intestine is classified as such when it is not due to any of the known etiological agents such as typhoid, dysentery, tuberculosis, syphilis, uremia, gastro-enterostomy, trauma, and tumors, a more descriptive term perhaps is simple non-specific ulcer. This is a relatively rare condition. Only 57 cases, excluding the 2 presented here, have been reported, chiefly in French, British, and Italian literature.

The first comprehensive review of the subject was made by Combes in a thesis at Toulouse in 1897. He stated that the condition was first described by Matthew-Baillie in 1805, and the term simple ulcer was applied by Cruveilhier. Combes described 36 cases, in 7 of which the ulcers were in the jejunum and in 12 in the ileum. Leotta, in 1919, added 13 more cases, in 2 of which the ulcers were in the jejunum and in 11 in the ileum. The first recording of any cases in this country was made by Richardson in 1922. He reported 1 case of his own and 1 culled from the records of the Massachusetts General Hospital, the ulcers in both occurring in the jejunum. Since then other cases in this country have been added by Gali, Bigger, Lind, and Brown and Pemberton (5). Brown (4), Babington, Stutch and Collier, and Fellowes have listed cases in the British literature, and Moirond in the French. Of the 57 cases published, in 44 the ulcers were in the ileum and in 13 in the jejunum.

Clinically, the presence of a simple non-specific ulcer is hard to detect. In none of the cases reported was a definite diagnosis made, a perforated ulcer being observed at operation or at post-mortem. In 1936, however, Brown and Pemberton (5) reported 9 cases in which operation was performed at the Mayo Clinic for lesions of the small bowel and in which solitary non-perforated ileal ulcers were found. This is the first report of these ulcers being operated upon before perforation occurred.

These ulcers bear a marked resemblance to peptic ulcers (6) in that they may cause intestinal hemorrhage (5), have a tendency to perforate, and histologically show only acute and chronic inflammatory changes.

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The clinical picture presented by these ulcers is varied. The ulcers usually occur in adults who are over 20 years of age, the majority of whom have reached late middle life. They are twice as common in males as in females. Usually there is a history of mild gastro-intestinal distress centered about the umbilicus or, more rarely, of slight intestinal hemorrhage, which may or may not be accompanied by other symptoms. The patient may complain of diarrhea or constipation for a short time prior to the onset of the acute illness. A secondary anemia and occult blood in the stool may be present without any additional symptoms, while all other clinical studies prove negative (5). As a rule, however, the patient is seen because of an acute abdominal condition at the time of perforation when he presents symptoms of acute appendicitis, intestinal obstruction, strangulated hernia, or peritonitis. The outstanding feature at this time, other than the symptoms just mentioned, is that the pain and tenderness are most acute around the umbilicus.

Various theories as to the cause of these ulcers have been presented. Gali thinks they are due to focal infection, citing his case of a woman who had a perforated simple ulcer of the ileum on three separate occasions, each time the condition being preceded by a furunculosis of the auditory canal. Brown (4) also inclines toward the theory of focal infection, citing the work of Rosenow on the selective affinity of certain strains of streptococci for the intestinal tract. Stutch and Collier favor the theory of vascular obstruction, stating that the histological examination in their case showed evidence of endarteritis and thrombosis in some of the vessels of the subperitoneal coat. Taylor (18) and Bigger think that trauma may play a part in this condition. Other authors, as Combes, mention its resemblance to peptic ulcer. The patient observed by us presented evidence histologically of two types of mucosa at the site of the ulcer, which may point to the part played by heterotopic gastric mucosa in the intestinal tract. Several cases of aberrant gastric mucosa in the jejunum and ileum, not associated with a Meckel's diverticulum, have been reported by Kimpton and Crane, Barták, Poindexter, and Taylor (17). Taylor's patient was a 17 months old child who died of intestinal ulceration and

hemorrhage. The specimen obtained at autopsy showed ulceration of gastric mucosa in the ileum. The patient of Kimpton and Crane was a 7 year old girl in whom intussusception was caused by a nodule of gastric mucosa in the jejunum. However at present, we may safely say that the etiology of this condition has not been established.

These ulcers may vary in size from a pinhead to 2 centimeters. They are punched out in appearance and terraced, the mucosal side being the larger. They may or may not be surrounded by a zone of inflammatory tissue. Usually the remainder of the bowel is normal, although more than one ulcer may be present. Sitch and Collier observed two simultaneous perforations in their patient. Histologically all show acute and chronic inflammatory changes. These ulcers are three times as common in the ileum as in the jejunum.

When brought to the attention of the physician the treatment is usually surgical, the procedure varying with the pathology found within the bowel. In 39 patients operated upon including 1 of our own, resection and anastomosis were performed in 18 with a mortality of 22 per cent. In 15 a simple transverse closure was done with a mortality of 40 per cent. In 3 cases excision of the ulcer and a transverse closure were carried out, with a mortality of 50 per cent. In

cases of simple closure with a short-circuiting anastomosis the mortality was nil. In 3 cases only drainage of the peritoneal cavity was employed, with 100 per cent mortality. The figures cited are not large enough to warrant drawing definite conclusions, but where possible the procedure of simple closure with a short circuiting anastomosis to obviate possible stricture of the intestines, seems to be the safest course. In those instances in which the ulcer cannot be closed because of surrounding induration or other causes resection and anastomosis should be employed. If the perforation is not large a simple closure may suffice. In any event the simplest procedure compatible with the condition encountered and the future well-being of the patient should be done.

CASE REPORTS

CASE. Mrs. M. K., his housewife, aged 5 years, was seen at Mercy Hospital on August 3, 1930. She complained of abdominal pain and vomiting of 8 hours duration. This pain, which began in the lower abdomen around the umbilicus, became progressively more severe and generalized. The patient had no similar attacks month and week, respectively before admission. These are not very severe and are not accompanied by swelling, and the pain cleared up both times after saline cathartics. Except for these attacks and the fact that she had no

bowel movement for 3 days prior to admission, the patient had been perfectly ill.

On admission, the patient's temperature was 100 degrees Fahrenheit, pulse 100 per minute, and respirations 25 per minute. The white blood cell count was 7,100 with 96 per cent polymorphonuclear cells. The abdomen was moderately distended with generalized rigidity. Tenderness was present throughout but most marked in the lower abdomen to the right and left of the umbilicus. The patient appeared very ill, presenting hypopneotic facies. A diagnosis of peritonitis, probably due to a perforated sac or diverticulum, was made. The patient was prepared for operation.

A low midline incision was made and as the abdomen was entered large amount of cloudy fluid was encountered. On exploration, loop of ileum about 5 inches from the cecal junction was found folded upon itself and covered with plastic exudate. The angle of the fold as the antimesenteric border as well as perforation, appeared to be 5 centimeters in diameter. It was punched out in appearance, with some induration of the surrounding

all. There was no evidence of the presence of any diverticula. It was impossible to close this opening because of its size and surrounding induration, so about 4 inches of the bowel was resected and lateral entero-enterostomy done. The appendix was removed prophylactically because of secondary inflammation of the cecum. The patient had stormy postoperative period but her temperature and pulse came down gradually until the fourteenth day. At this time after transfusion, the patient developed an autohemolysis of her blood, jaundice, and anemia, and died on the seventeenth day.

This resection was later found to be due to the presence of an anti-Z agglutinin in the blood. The presence of this rare agglutinin will be reported and discussed in separate publication. There is also question of typhoid in the case because of positive agglutination test as reported on the fifth post-operative day. Later agglutination tests were still weaker than the other tests are negative for typhoid, and the postmortem examination showed no evidence of typhoid.

The histological examination of the resected specimen showed ulceration and perforation with acute and chronic inflammatory changes, and evidence of two types of ulcers.

The postmortem examination showed extensive adhesions over the left upper abdomen. There was about 500 cubic centimeters of bloody fluid around the spleen, which was enlarged, friable, and contained numerous infarcts throughout. In the right lower abdomen there was localized, shelled-off abscess of the mesentery due to the opening of the proximal end of the ileum which had been inverted.

CASE. (Taken from the records of the Mercy Hospital.) A. J., colored male, aged 20 years, was admitted to the Mercy Hospital on August 20, 1931, complaining of severe generalized abdominal pain of 4 days' duration. The illness began with cramps centered around the umbilicus. These pains became more severe and were accompanied by vomiting. There was no previous history of gastrointestinal distress or illness of any account, other than constipation for 3 days prior to the onset of the present illness. The patient's condition on admission was peritonitic, the pulse being 94 and thready, the rectal temperature 102 degrees Fahrenheit, and the respirations 24 per minute. The white blood cell count was 9,050 with 48 per cent polymorphonuclear cells. His abdomen was rigid throughout and tenderness was most pronounced in the right upper abdomen. He was treated for shock and peritonitis but died within 24 hours.

The postmortem examination showed an extensive peritonitis and a perforated ulcer, about 1.5 centimeters in diameter, at the middle third of the ileum. The remainder of the ileum was normal.

SUMMARY AND CONCLUSIONS

To date 57 cases of simple non-specific ulcer of the jejuno-ileum have been reported. This is a relatively rare condition and is difficult to diagnose clinically. It resembles a peptic ulcer in that it may cause bleeding, has a tendency to perforate, and histologically shows acute and chronic inflammatory changes.

The etiology is not definite, but there may be some relation between this condition and the presence of heterotopic gastric mucosa in the small intestine.

Because of the complications produced, surgery is the only treatment, the procedure varies with pathological condition found in abdomen.

Two new cases have been presented and added to the literature.

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OVARIAN LESIONS SIMULATING APPENDICITIS

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It has long been recognized that various types of pathological conditions of the female pelvic organs may simulate appendicitis but comparatively few articles have stressed the frequency with which ruptured follicle or lutein cysts of the ovaries produce symptoms which are mistaken for those of appendicitis. Many of these cases are puzzling and defy accurate pre-operative diagnosis. No question can be raised as to the wisdom of surgical exploration if acute appendicitis cannot be ruled out of consideration at the end of a 36- to 48-hour period of illness, but in the majority of women with ruptured follicle or lutein cysts an accurate diagnosis can be made and the patient spared an unnecessary laparotomy—a procedure to which many women are now subjected.

The first recognition of abnormal hemorrhage from rupture of graafian follicle or corpus luteum cysts appears to have been by Nelaton in 1851, Rokitsky in 1855 and Puech in 1858. According to Phaneuf the literature previous to 1900 is not clear as to the distinctions between intra-abdominal hemorrhage from these sources and hemorrhages as a result of ruptured extra-uterine pregnancy. The frequency of hemorrhage from ruptured follicles or corpora lutea is a rather recent observation and Odermatt in 1923 was the first to draw attention to the fact that even though only 4 authentic cases had been recorded in the literature up to that date, 1 per cent of female patients operated upon for acute appendicitis had some intra-abdominal hemorrhage not traceable to a ruptured ectopic gestation. In a subsequent investigation on the same subject, Herrmann found 53 patients with corpus luteum hemorrhage among 539 female patients operated upon for chronic appendicitis. From 1930 to 1936 more than 100 authentic case reports have been contributed to the literature. Unlike the survey which we are about to present, the intraperitoneal hemorrhage in most of these patients was so severe that the diagnosis of ruptured ectopic pregnancy rather than appendicitis was the more logical conclusion. In November of 1936 Manizade gathered data on 67 patients with ruptured graafian follicles or corpora lutea whose symptoms were incorrectly diagnosed before operation as acute appendicitis

or ruptured tubal pregnancy. All these were confirmed by operation and histological examination. Most of these reports were incomplete with regard to the data on the menstrual cycle, symptomatology, differential diagnosis, etc. In view of the scant attention which this subject has received in medical literature and teaching, it is not at all surprising that the pre-operative diagnosis of ruptured follicle cyst or corpus luteum hemorrhage is seldom made, and some are falsely diagnosed even at operation.

Our study is based on a series of 52 consecutive case histories of patients admitted to various surgical services at St. Bernard's Hospital from January 1, 1933 to December 31, 1938. All of these patients were operated upon with the pre-operative diagnosis of appendicitis, either acute, subacute, chronic, or interval. The histories of these patients are reviewed in an effort to arrive at conclusions that may be of some value in the correct diagnosis and management of similar cases in the future. Cases in which definite appendiceal lesions were found at operation or on microscopic examination are not included. Also not included are those in which a pre-operative diagnosis of some form of adnexal pathology was made. During this same period there were 35,240 patients admitted to the hospital, of which number 8,424 or 23.9 per cent underwent major surgical operations. Of these 2,417 or 28.7 per cent were operated upon with the pre-operative diagnosis of some form of appendicitis. Thus we find that the diagnosis of appendicitis was the indication for operation in over one-fourth of all surgical cases. Table I shows that 75 per cent of these appear to have been correctly diagnosed before operation. In the 25 per cent which remained the diagnosis of appendicitis was either obviously wrong or highly doubtful.

This paper concerns an analysis of the last group shown in Table I. During this 6-year period many women were operated upon with the same pathology but with a pre-operative diagnosis of an ovarian lesion of some type. We have made no attempt to analyze those cases, as the majority of them were diagnosed as ovarian cysts. It may be noted that these 52 cases represented 3.3 per cent of all of the women in this series of 2,417 patients.

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GUY, ROTONDI OVARIAN LESIONS SIMULATING APPENDICITIS

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PRE-OPERATIVE DATA

In connection with this phase of the problem, the following points have been found to be of significance the age of the patient, the relation of the symptoms to the menstrual cycle, the social status of the patient, the rôle of trauma in the attack, and the symptoms and findings

Age of patient Of the 52 patients whom this paper concerns, 11 were between 14 and 20 years of age, 27 between 21 and 30, 12 between 31 and 40, and 2 between 41 and 46. It appears that the climax of frequency is in the third decade. After 35, the curve drops abruptly and no patient older than 46 years was observed. The average age was 25. Manizade reviews in the literature the case histories of 1 patient observed at 10, 1 at 12, and 4 more under 14 years of age.

Relation of symptoms to the menstrual cycle Even though the menstrual period antedating the attack was described as normal in all patients, 40 patients, or 76.5 per cent, complained of pain in the right lower quadrant between the twenty-first and twenty-seventh day after the last menstruation, while 12, or 23.5 per cent, experienced these symptoms on the fourteenth day after the last menstrual period. In the latter group, 8 gave a history of similar attacks for the past 6 or 7 years. Each attack occurred about 2 weeks before the onset of the catamenia and each time recovery occurred without surgical intervention. From these data it might be inferred that the symptoms felt in the mid-intermenstrual time may have resulted from ruptured graafian follicles while those that occurred later may have resulted from ruptured corpora lutea. Ray has reported on 11 patients with ruptured ovarian follicle which produced clinical pictures simulating appendicitis. In all of these patients the attacks appeared between the tenth and fifteenth day after the onset of the last menstrual period. Some degree of bleeding into the peritoneal cavity was found in all of them, and 5 were actively bleeding at the time of operation. This relationship between the menstrual cycle and the onset of the pain naturally suggests the possibility of some ovarian disturbance. It does not necessarily rule out appendicitis for the appendix may become inflamed at any time. Also, the appendix often hangs into the small pelvis, and not infrequently it forms adhesions with the adnexa. In fact, a direct anatomical communication between the ovary and the appendix may exist in the form of ligaments and lymphatics. The former is the infundibulo-pelvic ligament which may send a cord into the mesoappendix to the right and into the mesosigmoid to the left (7). Thus, by virtue of these

TABLE I — PRE-OPERATIVE DIAGNOSIS OF APPENDICITIS, 2,417 CASES

Postoperative diagnoses— Clinical pathological or both	Approximate per cent of total	
	Total	
Acute appendicitis	915	38}
Subacute, chronic, or interval appendicitis	894	37} 75
Normal appendix and no other pathological condition found	253	10.5
Appendix, normal or abnormal, plus some form of pelvic lesion	196	8.0
Appendix, normal or abnormal, plus some other form of lesion	107	4.5
Normal appendix plus ruptured follicle or lutein cyst of ovary	52*	2.0

*These 52 cases were 3.3 per cent of all females in this series)

anatomical relationships it is possible to explain not only the mechanism of the supposedly "spurious appendicular attacks" associated with menstruation, but also the congestion and even inflammation that may occur in the appendix at the same time that adnexal disease exists, without necessarily postulating the proximity of the two structures. Proof is offered by various authors (13, 15) that excess of secretion of estrin into the graafian follicle at some stage of its development may produce abnormal enlargement to the extent of cyst formation in the ovary. Likewise, failure of the corpus luteum to regress and disappear (in the absence of pregnancy) might result in the formation of an abnormal corpus luteum cyst. While these hormonal influences can explain in some way the mechanism of abnormal rupture of follicle or corpus luteum cysts, the matter of greatest importance is undoubtedly the clinical recognition of the condition. Seventeen of the 58 cases reported by Hoyt and Meigs were diagnosed accurately before the operation. Hence, it is unwarranted to assume that accurate diagnosis is impossible. Rupture of follicle and corpus luteum cysts is probably the most common cause of intra-abdominal hemorrhage, although the great majority of the hemorrhages are mild. No case of severe hemorrhage occurred in this series although many such have been observed by others and to date, the literature reports 7 patients who have died from such hemorrhage.

Social status The evidence indicated that 2 of our patients were virgins. Twenty-one were single and 29, or 56 per cent, were married women. We cannot concur with Krylov's opinion that follicle and corpus luteum hemorrhage are observed only in non-virgins.

Rôle of trauma in the attack In contrast with the reports of other authors (2, 10) that a history of physical exertion such as strain, defecation, sexual excitement, coitus, vaginal examination, dancing, swimming, lifting heavy objects, etc.,

usually precedes the rupture of the corpus luteum or graafian follicle, such data were obtained from only 5 of our patients. This, however, does not disprove the possible rôle of indirect trauma. Kermanner pointed out that there may be a cumulation of various releasing causes. The average interval between the time of physical effort and the onset of the symptoms was about 2 hours in these 5. In 1 the rupture occurred during sleep.

Symptoms and signs. With regard to the symptoms and signs, 27 patients had only vague complaints suggestive of appendicitis. In these the abdominal pain was generally first felt low in the abdomen but it was of short duration or it disappeared and reappeared at intervals, and frequently was felt in different locations. In 25 however the pain was recorded as being sudden in onset, sharp in character, first generalized over the abdomen and later localized in the right lower quadrant. In 4 of the latter the pain radiated to the back, and in 2 it was referred to the right shoulder. According to Borras this path of reference is due to a complicated reflex process in the sympathetic plexuses with the arc from the adnexa to the phrenic nerve. Only 2 women complained of fainting. Nausea and vomiting followed the pain in 5 patients, in all of whom the pain had lasted more than 3 hours. On analyzing these symptoms, they were found to be present in those patients in whom pelvic hematomas were discovered at operation. The temperature was recorded as normal in practically all 53; but these were generally month temperature readings. Rectal temperatures might have shown different results. The pulse rate showed only slight elevation, and in no case did it exceed 100. The leucocyte count showed a definite increase in the great majority of patients, although the leucocytosis was relative rather than absolute, as shown in cases in which a differential blood count was made. The white blood count in 9 patients was 6,000 to 10,000 in 8 patients, 9,000 to 12,000 in 7 patients, 13,000 to 14,000 in 1 patient, 9,000 and in 4 patients, 1,000 to 13,400. The average count was 1,500; 2 had 6,000. Urinalysis was essentially negative in all cases.

Unfortunately findings on rectal and vaginal examinations were recorded in the histories of only 4 patients in 53 of these patients a doughy fullness suggestive of an accumulation of blood or blood clots was felt in the cul-de-sac. Vaginal examinations on others were done previously and admission to the hospital but the findings were not recorded. Most of these cysts are too small to be diagnosed as such by bimanual palpation but definite ovarian tenderness, if elicited, is of value

in the differentiation of them from appendicitis. Abdominal tenderness was elicited in all patients, the maximum degree usually being somewhat medial to and below McBurney's point and nearer the symphysis pubis. However the point of maximum tenderness in appendicitis may be in an atypical site (1). In 5 patients the tenderness shifted to the upper quadrant. Rigidity and muscle spasm were not a constant finding, neither was increased peristalsis on auscultation of the abdomen.

OPERATIVE DATA

None of these patients had had a previous laparotomy performed. A right rectus incision was made in all cases. Twenty-four surgeons performed the operations. One surgeon had 6 patients; 3 others had 5 each; 3 had 4 each; 2 had 3 each and 15 other surgeons had 2 each. Unlike the data in many reported cases, free blood was found when the peritoneal cavity was opened in only 2 patients of this series. Thirteen had what might be considered moderate hemorrhage in the pelvis. In 24 the bleeding was very slight and seemed to come from a pin-point area on the right ovary. The left ovary was involved in only 2 patients, although the symptoms in these were localized entirely on the right side. In 3 other patients observed by one of us (C.C.G.) in other hospitals, the pain and tenderness were entirely in the right lower quadrant but the ruptured cyst in each was in the left ovary. We can advance no satisfactory explanation for this paradox. Of the 11 patients whose histories are reported by Ray, the right ovary was involved in 7 and the left ovary in 4. He comments on the predominance of pain and tenderness on the right side even in those patients in whom the lesion was located in the left ovary, but he attempts to make no explanation of this observation. In 11 of our patients there was no evidence of active oozing, the condition having been discovered during the process of pelvic exploration after apparently innocent appendix had been removed. A clear serous or blood-tinged fluid was found in the pelvis in these, probably the result of ruptures of graafian follicles. According to Novak the amount of hemorrhage depends largely on the location of the rupture of the cyst structures in relation to its blood vessels. A rupture in a relatively a vascular area produces very little bleeding. Plastic resection of the hemorrhagic cyst alone was done on 1 patient. Twenty-nine were treated by partial oophorectomy and 2 others by total unilateral oophorectomy. Two of the latter were the 2 patients over 40 years of age. Simple suture of the bleeding tissue was not done. In 40 patients, or

76.5 per cent, the pathological diagnosis was hemorrhage from corpus luteum cyst. Twelve, or 23.5 per cent, appeared to be ruptured graafian follicles. The excised ovaries showed edema and fibrocystic changes but no true inflammatory reactions were found. In 2 there was diffuse follicle cyst formation. None showed histological evidence of pregnancy thus disproving Forssner's contention. Appendectomy was performed on all patients. Gross and microscopic examination of all of these appendices failed to reveal pathological changes which appeared sufficient to produce symptoms. Incidentally, in 15 women of the series normal menstruation appeared on the third postoperative day. All recovered uneventfully.

PHYSIOPATHOLOGICAL ASPECTS

Physiological rupture of a graafian follicle and the formation of a corpus luteum (ovulation) is thought to occur usually between the twelfth and nineteenth day before the onset of the period. Any disturbance in the process of follicular ripening from hormonal, traumatic, or other causes may result in a pathological rupture with extravasation of clear white to yellow coagulated fluid and sometimes actual hemorrhage. The severity of the symptoms depends to a large extent on the amount of intraperitoneal bleeding that occurs with the rupture. In most instances it is of little consequence. The pain that results from it resembles "gas" pain, it rarely incapacitates the patient and seldom lasts more than 3 hours. It is in the exceptional case in which the hemorrhage is diffuse, and this symptom can easily be confused with that of ruptured tubal pregnancy. Yet, a thorough menstrual history, especially in women whose catamenia are regular, is helpful in the differential diagnosis. Thus, if the symptoms occur between the twelfth and the nineteenth day after the last menstruation, they may be due to rupture of the graafian follicle while the more pronounced abdominal symptoms which are likely to occur 7 to 10 days before the onset of the next period may be due to rupture of corpus luteum cysts. Previous similar attacks are very suggestive but, unfortunately, a history of previous attacks is also frequent in appendicitis, the disease with which it is most often confused. The argument, therefore, is not so much against the removal of an innocent appendix, but for the realization of the fact that after appendectomy, with or without the performance of oophorectomy, the symptoms may recur, and if one ovary has already been removed, the reproductive and endocrine functions of the patient are needlessly impaired. Consequently, the opinion that a ruptured corpus

luteum or graafian follicle cyst is invariably a surgical problem is not shared by the authors. It seems questionable to expect that the great majority of these women will be permanently benefited by operation. If an accurate diagnosis is made and mild attacks recur, endocrine therapy may be of value (5).

SUMMARY

1. Rupture of follicle and corpus luteum cysts may simulate a surgical condition of the abdomen. This is not rare, since the histories of 52 patients whose symptoms were erroneously diagnosed as appendicitis have been gathered and studied in a 6-year period from a 200 bed hospital.

2. The relation of the time of onset of the symptoms to the menstrual cycle is found to be of major diagnostic importance.

3. About one-half of the patients experienced sudden pain in the lower abdomen at the onset. This is a second important diagnostic sign.

4. Vaginal or rectal examination may be helpful in the diagnosis and should always be done.

5. In most of the patients the symptoms experienced are mild, can be correctly diagnosed, and spontaneous recovery can be expected. In other patients, the symptoms and clinical findings are more pronounced and may so closely simulate appendicitis, tubal pregnancy, or other pelvic lesions that surgical exploration is advisable.

6. If operation is performed, every effort should be made to conserve the maximum amount of ovarian tissue.

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EDITORIALS

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JUNE, 1940

PROSTATIC SURGERY

FOR some obscure reason the treatment of the obstruction to urination due to disease of the prostate gland has long been the subject of lively controversy. It arose first between the proponents of operation on the one hand and those of catheterization on the other. The former triumphed when it proved that in the long run catheterization had the higher mortality. Then came the quarrel between the perineal and the suprapubic operators. Its echoes were still resounding when such hardy pioneers as Caulk, Davis, Bumpus, and Alcock raised the question of transurethral resection, and the debate, which is still in progress, became three cornered and increased in intensity.

Several factors contribute to the current disagreement as to the selection of the proper operation for a given case of prostatism. Suprapubic prostatectomy is the more widely used of the open operations because it is easy to perform and carries almost no risk of incon-

tinence. Its high mortality and long, often unpleasantly moist convalescence have been potent arguments for the adoption of transurethral resection.

Perineal prostatectomy is difficult to master but has a low mortality. The very real and definite danger of urinary incontinence and recto-urethral fistulas which accompany its use have prevented its widespread adoption and have, to some extent, promoted acceptance of the endoscopic operation. It also is likely to be followed by a long, damp, malodorous recovery.

Many instruments and operations for transurethral removal of the prostate were tried and discarded as dangerous and futile in the second half of the nineteenth century, especially by Guthrie, Civiale, Mercier, Bottini, and Wishard. Although Young described the successful use of his punch as early as 1911, he employed it only in contractures of the prostate, and it was not until about ten years ago that Caulk first succeeded in convincing others that prostatic hypertrophy was amenable to operation by endoscopic methods. Shortly thereafter, some of his early followers greatly underestimated the seriousness of the procedure and reported, very prematurely indeed, that it was so free from risk that it could be done "in the office", many who were encouraged by such reports were so speedily and violently disillusioned by their own experiences as to abandon it forever.

Another definite obstacle to the widespread adoption of the operation is the fact that its successful performance requires a wide experience, first with the cystoscope, and later with the resectoscope, with an opportunity to begin with the smaller glands and, as experience

increases, very gradually to attack the larger ones. Opportunities for the acquisition of such experience are difficult to find.

Habit has also served to prevent wider employment of the transurethral operation. This was well expressed by the surgeon who asked, "Why is it that, just when I learned to do a decent prostatectomy, someone had to change the rules?"

The fact that even a well conducted transurethral resection leaves a certain amount of abnormal tissue behind cannot be denied; the danger that this will give rise to recurrent obstruction has been advanced as a reason for abandoning the operation in hypertrophy of the prostate. Before doing so one must remember that hypertrophy develops so slowly and the average patient is so old, that death from other unrelated causes is likely to precede recurrence. It is not amiss to point out that the literature contains many instances of recurrence following enucleation of hypertrophies from patients who lived unusually long after operation.

Another objection advanced particularly by Young is based upon the incontrovertible fact that transurethral resection cannot cure a prostatic cancer concealed in a spheroid of benign hypertrophy while enucleation or radical perineal prostatectomy may do so. The fact is, as I have pointed out, that such a small number of prostatic cancers are curable by any means at the time of their discovery—one to three per cent.—that the lower mortality of transurethral resection entirely compensates for the lost cures.

It has also been suggested that urinary incontinence has become so frequent as a result of the employment of the transurethral operation as to constitute a windfall for manufacturers of incontinence clamps and bags. It has apparently not occurred to many who cite this fact that the frequent occurrence of inconti-

nence is a reflection upon the operator rather than upon the operation.

Notwithstanding these conflicting ideas certain facts concerning the merits of the transurethral operation are well established. First, the expert can if he chooses, resect all but the monstrous enlargements of the gland although the resection of the larger ones is tedious for patient and surgeon alike and may require multiple stages.

Second a potent factor in the adoption of transurethral resection has been its low mortality in skilful hands. Caulk, Davis, Thompson and others have reported large series of cases with a mortality of one half to one per cent. While it is perfectly true that the average surgeon cannot achieve such results, it is equally true that the mortality of two to three per cent reported by Young and Davis after perineal prostatectomy and that of 5.4 per cent by Hunt after the suprapubic operation cannot be equalled by the average operator. Nevertheless, the ratio of 1:355 probably represents the relative risk of the three operations well performed for proper indications.

A third point in favor of the transurethral route is that it requires a relatively short hospital stay. Thompson having been able to dismiss two-thirds of his cases after 5 to 7 days a fair average for the pre-operative and post-operative stay is ten to fourteen days. Open operation, on the other hand, is likely to require four weeks or more of hospitalization although some patients are able to leave earlier.

Fourth, the transurethral operation achieves an enormous saving in discomfort and post-operative care by eliminating the wet pack and the need for dressings.

Bearing these facts in mind, one may draw up a tentative set of rules, always subject to modification, for the selection of the proper operation in a given case of prostatism.

The general surgeon should avoid the transurethral operation entirely unless he has had an unusual training, and has a large proportion of urological patients, since it is as much a specialist's operation as is trigeminal rhizotomy. Whether the general surgeon elects the suprapubic or perineal route for open operation is a matter of personal preference although it must be understood that, while the perineal route has a lower mortality, its use by surgeons without special training is fraught with disturbing possibilities of incontinence and recto-urethral fistulas. Undoubtedly the best operation for the general surgeon is the two stage suprapubic, in which he employs a technique of cystostomy which minimizes trauma and allows ample time for full recovery before he performs a blind intraurethral enucleation and packs the prostatic cavity. In this way he avoids such pitfalls as primary closure.

Safe guides for the selection of the individual case are somewhat as follows:

Prostatic fibroses are amenable only to transurethral resection, since they cannot be enucleated.

The obstruction of prostatic carcinoma with local extension or metastasis is most easily and safely relieved by an endoscopic operation. Localized carcinoma may be cured by radical perineal prostatectomy, an operation which can be done well by but few surgeons.

Small hypertrophies are best treated by resection although they can be removed, at somewhat greater risk and expense, by the open method.

Large hypertrophies are best treated with suprapubic prostatectomy except in the hands of the expert in the perineum. It must be remembered that the term "large" is relative since one surgeon may be quite capable of removing more than a hundred grams of prostatic tissue quickly and safely by the trans-

urethral route, while another may exhaust both the patient and himself in removing more than ten or fifteen grams of tissue.

While this scheme of treatment may arouse the objection that it requires referring the majority of patients to the specialist, this objection is not valid if one considers the welfare of the patient which is, after all, the surgeon's primary objective.

C. D. CREEVY

THE PROPER USE OF THE TERM "CANCER"

IT is unfortunate that the term *cancer* should so often be interpreted in a limited sense as applying to malignant tumors of epithelial origin only, i.e. carcinoma. There is need for a definite term, a single word, to define the general group of malignant neoplasms—carcinoma, sarcoma, endothelioma, myeloma, melanoma, etc., collectively—and there is none available except "cancer," which originally had this broad meaning. The necessity for the broad conception of this term is proved by its frequent use in that sense in the lay and medical press. In most foreign languages, the word is not used in its limited sense.

Synonyms are "malignant tumor," "malignant growth," "malignant neoplasm."

The term *malignancy* is an abstract noun meaning "the state or quality of being malignant, the tendency to a fatal issue, the tendency to go from bad to worse." The term "malignancy" therefore is one of the qualities or characteristics of cancer and also of a number of other diseases. There is no authority for using it as a concrete noun and a synonym for cancer. When improperly used, the error should be corrected by substituting the term "cancer" or one of its synonyms as given above.

The clearest (abstract) meaning of this term will in most cases require the addition of the preposition "of" as for instance in speaking of the malignancy of a growth or of any given disease. Although it may of course be correctly used as an abstract noun standing alone, nevertheless, the omission of the preposition "of" is apt to lead to errors in construction.

The term *malignant disease* designates any disease which tends to go from bad to worse or which tends to a fatal issue. It is obvious that from the quantitative standpoint, the most malignant disease therefore is that which causes the most deaths, that is that ill assorted collection known as "heart disease." Cancer comes second from this standpoint. From the qualitative standpoint cancer can often be cured, while many diseases, as for example, tetanus, are almost always fatal, and lastly many diseases cause death more quickly than cancer as for instance septic endocarditis or typhus. It is obvious, therefore that the term "malignant disease" is ill-chosen and improper when used as a synonym for cancer.

The terms *carcinoma* and *epithelioma* refer exclusively to growths of epithelial origin, which are admittedly the most frequent of malignant tumors. Nevertheless, connective tissue tumors (sarcomas) may occur in any organ or part of the body and the title of a general paper on any of these subjects necessitates the use of the word "cancer" or one of its synonyms. The title *carcinoma of the breast* excludes by inference any connective tissue tumor of the breast, which is usually not intended and furthermore is both unnecessary and unwise.

The terms *carcinoma* and *epithelioma* are best reserved for the discussion of the histological type of cancer and usually had best be accompanied by a qualifying prefix or adjective as for instance *squamous carcinoma*, *adenocarcinoma*, *lympho-epithelioma*, etc. In the majority of instances when the word *carcinoma* alone is used in medical writing without further qualification the meaning would be made clearer if the word "cancer" or one of its synonyms were substituted for it.

The old anatomists speak of *lymph glands*—a term which arose at the time when lymph nodes were considered as secretory organs. At the present time, their true function is known, and there is no longer any justification for calling them glands—a practice which leads to some confusion. For instance when lymph nodes of the neck are called "glands of the neck" or "cervical glands," the less clear thinking and less well informed physician is often erroneously led to believe that metastasis takes place indiscriminately to the true glandular structures of the neck which are the parotid salivary gland the submaxillary salivary gland the sublingual gland and the thyroid gland.

While there is less confusion as regards the lymph nodes of the axillae, groins, and such regions, good practice calls for the use of *axillary lymph nodes*, rather than *axillary lymph glands*. In medical journals, the elimination of the use of the term "glands" in referring to lymph nodes would soon correct the present day tendency which is so widely prevalent to commit this error.

HAYES MARTIN

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

JOHN Homans has long written authoritatively on circulatory diseases of the extremities. The advent of his monograph¹ on the subject, therefore, could not fail to arouse interest. In contrast with other numerous recent publications in this field, his volume covers disturbances of all of the component systems of the peripheral circulation, including diseases of the arteries and veins, abnormal arteriovenous communications, and obstructions to the lymphatic return. The book is well balanced and well written. It is restrained and scientific in tone and thoroughly fulfills the high standard expected of it.

The work is primarily intended for the general practitioner who is first called upon to recognize and treat disorders of the peripheral circulation. In the section on arterial diseases, therefore, emphasis is placed upon diagnostic tests and therapeutic methods generally available and requiring no unusual apparatus or equipment. On the other hand, the critical evaluation of recent contributions and the description and illustration of operative procedures should be of interest to the surgeon particularly concerned with vascular disturbances. There is a notable reserve toward certain therapeutic measures that contrasts with the enthusiastic reports of other writers. In addition to the usual chapters devoted to arteriosclerosis and thrombo-angitis obliterans, there is an interesting grouping of the numerous diverse, and little understood ischemic conditions under the general heading of spastic arterial states, with particular attention to their presumed reflex origin and to methods of interrupting the pathological reflex cycles.

The author speaks with greatest conviction when discussing disturbances of the veins, a study to which he has made notable contributions. Consonant with his earlier views, he is still rather restrained in his attitude toward the injection treatment of varicose veins and considers it, at best, an adjunct to properly placed ligations of the venous trunks. Surgical excision of varicosities finds wider indications than in most current writings on the subject. The chapter on thrombophlebitis and pulmonary embolism encompasses his extensive observations on this phase of vein disease and is, therefore, one of the most valuable in the book.

Case reports and adequate illustrations enhance the clarity of the presentation. A selected bibliography is appended to each chapter. In general, this is the most satisfying monograph on the subject of circulatory diseases that has appeared in recent years. It should prove of interest and value to all

who treat these conditions, and this, of course, includes almost all who practice medicine or surgery.

LEO M. ZIMMERMAN

IN the second edition of his book, *Blood Groups and Blood Transfusion*,² Dr Wiener has reviewed the recently accumulated knowledge concerning blood groups, subgroups, sources of error in blood grouping, the use of preserved blood for transfusion, blood transfusion reactions, medicolegal aspects of blood groups, and differences in animal blood.

The section on the history of blood transfusion is the only division not revised in this new edition. Particularly valuable is the greatly enlarged chapter on blood transfusion reactions which includes much recently published material not previously available outside of current periodicals. In his discussion of methods the author has given no consideration to the simple closed citrate transfusion apparatus which is being used successfully in hospitals and large clinics.

The monograph offers in a readily available form all the information necessary for the carrying out of a complete blood transfusion. No hospital laboratory should be without access to this book and it can be recommended particularly to those young men in our hospitals who are performing the majority of blood transfusions.

THOMAS C. DOUGLASS

THE author of *Tumors of the Skin*³ has been deeply interested for years in the study of neoplasms and in order to obtain information on various phases of the subject he frequently found it necessary to consult many sources. For this reason he felt that there was a need for a single comprehensive and practical volume on the diagnosis and treatment of benign and malignant tumors of the skin.

The book is not a large one but covers the most important details of benign and malignant neoplasms of the skin. Under benign tumors are discussed tumors of connective tissue origin, tumors originating from muscle or nerve tissue, nevi, and other developmental disturbances of the skin, tumors of infectious origin, and precancerous conditions. Malignant tumors are treated as carcinomas, malignant melanomas, sarcomas, and lymphomas. The volume contains brief but adequate descriptions of all of the neoplasms, supplemented with excellent photographs, both clinical and microscopic. Treatment is adequately given at the end of each subject.

²BLOOD GROUPS AND BLOOD TRANSFUSION. By Alexander S. Wiener. A. B. M. D. 2d ed. Springfield Ill. and Baltimore Md. Charles C. Thomas 1939.

³TUMORS OF THE SKIN. BENIGN AND MALIGNANT. By Joseph Jordan. Ellers M. D. Philadelphia. Lea & Febiger 1939.

¹CIRCULATORY DISEASES OF THE EXTREMITIES. By John Homans. M. D. New York. The Macmillan Co. 1939.

There is an excellent chapter on cutaneous surgery and plastic repair of skin tumors which discusses in detail various types of incisions, closures, indications for the various kinds of skin grafting, and the technique used for them. Finally there is an appendix containing practical data on radiation, physics, and biology. In addition there are dosage tables and charts which are useful in determining the proper procedure and dose to be employed.

While the author discusses his own technique in the use of roentgen rays and radiation in the treatment of cancer, he makes it plain that good results may also be obtained with different techniques and dosages. One of the few criticisms that can be made of this excellent work is that in some instances the dosage suggested may not be excessive in the hands of an experienced operator like the author but in less experienced hands such dosages may prove to be dangerous. The average physician will have difficulty in understanding the various dosage tables in the appendix. While there are undoubtedly readily understood by the expert radiologist it would seem best to interject some explanatory text for the benefit of the average practitioner.

A special feature of the book in the chapter on carcinoma, and an excellent one, is a series of diagrams of tumors of various types, sizes, and locations, with practical discussion of the different methods of therapy which may be used for each lesion.

Every subject is well organized and at the end of each chapter is an extensive bibliography. The text reads smoothly and the illustrations are numerous and excellent. Seldom does one see such a large number of uniformly choice illustrations. The print is large and legible and the author and publishers are to be most earnestly congratulated for producing such a fine volume. EDWARD A. OLIVER.

THE present volume of *Transactions of the Third International Goiter Conference and the American Association for the Study of Goiter* contains 6 papers on thyroid disease. Kimball reviews "Twenty Years in the Prevention of Goiter." He says, "The incidence of goiter among the school children of Cleveland in 1924 was 3 per cent. In this community however the prevention of goiter and especially the generalized use of iodized salt had been frankly and repeatedly criticized by some well known surgeons. There was such a widespread fear of the so-called 'dangers of iodized salt' that less than one-half of the homes in Cleveland ever used it. In 1936 resurvey showed the total incidence of goiter to be 8.5 per cent. Among those using iodized salt regularly it was 7.7 per cent. and among those not using it at all the incidence was 30.7 per cent, or practically the same as in 1924. He concludes "The addition of an exceedingly small amount of iodine to our food (one part sodium iodide to ten thousand parts of salt) in

endemic goiter regions prevents goiter. There is no basis for the old teaching that the general use of iodine in amounts sufficient to prevent goiter might have some injurious effects. The prevention of endemic goiter will prevent adenomas and toxic goiters, cretinism and cretinoid type of subnormal mentality, deaf-mutism, congenital malformations and many cases of infantilism in girls or a relative subnormal development. Similar enthusiastic reports are given by Eggenberger and Messeri from Switzerland. Other papers from Mexico, Finland, Poland, and Russia discuss goitrogenic factors.

The 6 papers in the next section are concerned with thyroid disease in childhood. The fourth section contains 5 papers on tumors of the thyroid. The fifth section is concerned with the endocrine physiology of the thyroid. The sixth section is surgical, the seventh, medical, the eighth is a symposium on iodine metabolism with important papers by Curtis, McClelland, Perkin, Litchfield, and Webster. The ninth section concerns the vitamins and the thyroid. The tenth has several experimental papers. The eleventh is composed of 3 papers on basal metabolism. The volume closes with a paper on ray therapy and one on colloid goiter.

In general, this volume contains very valuable material in every phase of thyroid physiology and disease. PAUL STARR.

FROM the long experience of a large surgical practice there has evolved the practical book on ophthalmic surgery *Surgery of the Eye*, by Wieser and Alvis. No claim is made that it constitutes an exhaustive treatise on all known techniques and methods, but the authors have attempted to present in detail the operative procedures which in their hands have proved to be most effective. For this reason some rather widely used forms of ophthalmic operations and technical modifications are omitted from the text. Some surgeons may disagree with the choice of operations in some instances but such disparity of views is unavoidable in text as personal in nature as the present one.

The classical description of dacryocystectomy found in Meiler's widely utilized book has been used as a model in describing operative stages. For the most part operations are described in a lucid, explicit and detailed manner and only occasionally does the language become sufficiently involved to require a rereading. The greatest asset of the book and its most commendable feature is the complete and intelligent manner in which it is illustrated. The 356 drawings are sketched and then finished by D. A. J. Hoffmeyer, an artist who is also medical graduate. They are accurate and comprehensible, and serve to clarify descriptions which could otherwise, by their very nature, be difficult for the novice to comprehend correctly.

Separate chapters are devoted to (1) general consideration (2) preparation of the patient (3)

TRANSACTIONS OF THE THIRD INTERNATIONAL GOITER CONFERENCE AND THE AMERICAN ASSOCIATION FOR THE STUDY OF GOITER, 1938. JAMES M. KIMBALL, Editor. C. Partridge, Oregon. The Western Journal of Surgery, Gynecology and Obstetrics, 1939.

THE SURGERY OF THE EYE. By NEWMAN WESER, M.D., and BENNETT T. ALVIS, M.D. Philadelphia and London: W. B. Saunders Co. 1939.

anesthesia, (4) pre-operative preparation, (5) post-operative care, (6) paracentesis, (7) cataract, (8) glaucoma, (9) operations on the retina and sclera, (10) intra ocular foreign bodies, (11) operations on the cornea, (12) removal of the eye, (13) operations on the conjunctiva, (14) operations on the lids and socket, (15) ptosis, (16) muscle operations, (17) operations on the tear apparatus

There have been in the past few acceptable textbooks on ophthalmic surgery written in the English language. Therefore, the present effort is a welcome addition to the ophthalmic surgeon's library.

WILLIAM A. MANN

A TEXTBOOK of surgical anatomy may be either primarily clinical or anatomical, it may teach procedure and merely employ the facts of gross anatomy in supportive capacity, or may emphasize anatomical structure while presenting surgical concepts as general corollaries. The *Manual of Surgical Anatomy*¹ belongs definitely in the latter category. The descriptions are primarily anatomical, arranged in the regular order of successive stratification. For example, in presentation of the surgical anatomy of the head, palpable bony landmarks are first described, next the skin and its regional peculiarities, then the subcutaneous tissue and the latter's vascular content, the epicranial aponeurosis, the pericranial periosteum, the skull, and finally the brain and meninges. Appropriately placed are the comments on the surgical importance of each layer: the mobility of sebaceous cysts, the limitation of hemorrhage by the density of the superficial fascia, viability of torn flaps as dependent upon richness of blood supply, the broad spread of hemorrhagic or purulent masses when situated beneath the aponeurosis of the cranial muscles, intersutural restriction of similar collections when they lie beneath the pericranium, the laminar structure of cranial bones in relation to fractures, the spread of infection from ear and mastoid to the venous sinuses, and the anatomically advantageous position for sampling the cerebrospinal fluid.

The extremities are similarly treated. For example, in the discussion of the upper extremity, the muscular and bony prominences are first described, then the course of superficial nerves, and the areas to which pain is referred from thoracic, phrenic or subphrenic pathology, the scheme of superficial venous drainage and the sites of hematoma, the course of the arteries with points of convenient ligation, the joints, ligaments, and surrounding muscles in relation to the common positions of dislocations, the routes of lymphatic drainage, and the synovial sheaths with relation to spreading tendovaginitis.

Of the descriptions of the several serous cavities, that of the abdomen may be selected as an example. The peritoneum is discussed with detailed commentary on the spread of infections within the sac,

the natural control of such conditions by the great omentum, and the sites for incision in drainage of purulent masses. The separate portions of the digestive tube are described fully as they appear in the living patient, in the cadaver, and in roentgenograms, the lymphatic drainage of each organ is presented in relation to malignant involvements, and the physiological features affecting resection are discussed.

More than one-fourth of the 187 figures in the book are used in either Cunningham's *Manual* or Cunningham's *Textbook*, or in both of these. Most of the new figures are radiographs, which had been added in the previous edition and repeated in the current one, roentgenograms, in fact, make up almost one-fifth of the total number of figures in the volume. Some figures on developmental anatomy are presented, they are conventionally diagrammatic. Normal variation is sparingly handled, there are figures only of the modes of termination of the biliary and pancreatic ducts, of the degrees of persistence of the vitello intestinal duct, and of the varying relation of the cecum and ascending colon to the peritoneum. Vascular variations of surgical importance are neglected.

Relatively few of the figures are surgical. Unlike the plan followed in a recently revised American textbook of surgical anatomy, the Beesly and Johnston edition does not illustrate successive steps in the exposure, repair or excision, and closure of surgically important structures. Figures which may be regarded as surgical at all are fundamentally topographical, they illustrate cistern puncture, sites of alveolar abscess, route of approach in malignancy of the tongue, lines of incision in the hand and the abdominal wall, and types of hernial sac.

The volume is very readable and the arrangement of its subject matter admirable, it gives the impression of completeness and carries an air of quiet authoritativeness. The book is a corpulent octavo of more than 700 pages which would fit handily into the larger pocket of a macintosh. BARRY ANSON

THE text of Professor Clark's *Tissues of the Body*,² which is designed to present in modern fashion the structural organization of the living body, the dynamic bases of human anatomy, opens with a general discussion of cells and tissues. A concise account of technical methods follows describing such procedures as dissection, histological technique, reconstruction from serial sections, tissue culture, and vital staining. A serviceable chapter is devoted to the development of tissues in the embryo. Although form is of first importance to the anatomist, no mention is made of the shape of cells in layers, so ready is histology to espouse chemistry when its natural allies are the physical sciences.

In the discussion of connective tissue the account is not unlike that found in any one of the American

¹BEESLY AND JOHNSTON'S MANUAL OF SURGICAL ANATOMY. 5th ed. Revised by John Bruce M.B. F.R.C.S. (Edin.) and Robert Walmsley M.D. London: Oxford University Press, 1939.

²THE TISSUES OF THE BODY, AN INTRODUCTION TO THE STUDY OF ANATOMY. By W. E. LeGros Clark F.R.S. Oxford: Clarendon Press, 1939.

textbooks of histology. The treatment of the macrophage system is illuminating and gives a serviceable concept of its broad distribution within the body in connective tissue. Liver lymph glands, leptomeninges, and central nervous system. Similarly helpful to the student is the proper placement of superficial and deep fascial layers in the scheme of supporting tissues.

Cartilage receives scant attention, as is regularly the case in textbooks, and often in the larger edited works. Bone on the contrary is dealt with to some length in most able fashion; all phases are considered from comparative anatomy, through development, to surgical significance of the periosteum. A simple account of ossification is followed by an appraisal of features controversial in nature. All the mechanics of bony architecture, the factors influencing the initiation of ossification, and the ultimate shape of bones receive attention.

In the section on skeletal muscle, not only is the structure of the myofibril considered but the organization of the fibrils into named muscles of various forms (siform, flat, penniform, etc.). The physiological principles governing contraction, the atavistic variations in the muscular system, and regenerative changes of higher mammals, and the regeneration and repair of muscle tissue are also discussed. Visceral and cardiac types are more briefly treated. Some lost causes are given passing note, as for example, the double innervation of skeletal muscles, and, in this way, are given decent textual interment.

On the subject of blood vessels the new concepts regarding endothelial growth are presented, as are also those concerning the establishment of embryonic vascular patterns and the mode of innervation of blood vessels. This is done without disregarding the more conventional material. On the subject of

lymphatic capillaries the important recent work on direct observation of the living vessels is both described and figured.

Mucous membranes and their glands are discussed, first in the ordinary way then with consideration of special features: the macroscopic features of glands, to relate gross to microscopic appearance, the anatomy of secretion, to correlate cytological elements with histological appearance, the embryology of secretion, to relate the adult position and form of the glandular masses to the manner of their embryonic formation.

To the more conventional discussion of the skin is added a consideration of fissure lines, racial variation in pigmentation, hair tracts, and hair growth.

The volume closes with a section on the tissues of the nervous system. The general account is enlivened by a discussion of the differentiation of neural mechanisms and the evolution of nervous organization. An explanation of methods of studying experimental and clinical material is appended.

Professor Clark's treatise is emerging and diverting. It is very well written and the subject matter is judiciously selected. Since it is the work of a single author the presentation is even, the parts nicely correlated. One encounters none of the irritating disjunction, irregularity of treatment, and lack of integration which characterizes the more pretentious histologies produced under editorship. Just the optimum number of references is given. The photomicrographs are excellent.

The book could not be used by student in American medical school as a substitute for his regular textbook of histology but it could form a highly valuable addition to his library. For the graduate in medicine its usefulness would be even greater.

B. R. ARMSTRONG

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

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CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

GEORGE P. MULLER, Philadelphia, *President*
EVARTS A. GRAHAM, St. Louis, *President-Elect*

Committee on Arrangements
JOHN A. WOLFER, *Chairman*, CHARLES B. PUESTOW, *Secretary*

PRELIMINARY PROGRAM FOR 1940 CLINICAL CONGRESS

THE thirtieth annual Clinical Congress of the American College of Surgeons will be held in Chicago, October 21 to 25, when surgeons of this medical center plan to present a program of operative clinics and demonstrations covering all phases of the clinical activities of the five medical schools and forty or more participating hospitals. Representing as it does the interests of all surgical specialists as well as general surgeons, this Clinical Congress, under the leadership of a strong and representative committee, will assure a complete and varied program for all those who will attend. The five day program will include a presentation of the latest advances in diagnostic methods, surgical technique and operative procedures, and the after care of the surgical patient. A preliminary schedule of the clinical programs at a number of the hospitals and medical schools, prepared at the direction of the committee, appears in the following pages. Other hospitals that will participate in the Clinical Congress are Children's Memorial, Evangelical, Grant, Illinois Central, Loretto, Municipal Contagious Disease, Ravenswood, Shriner's Hospital for Crippled Children, United States Marine. Clinics and demonstrations will be held on the afternoon of Monday, October 21, and the mornings and afternoons of each of the succeeding four days.

CLINICAL PROGRAM

The committee is arranging an extensive schedule of operative clinics in which the technique of a wide variety of surgical procedures will be demonstrated in the operating rooms. The program is being planned, in so far as possible, so that it will also cover related problems in diagnosis, pre- and postoperative care, and other special aspects of the management of the surgical condition under consideration.

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A series of non-operative clinics, demonstrations, and exhibits is planned in many of the larger hospitals for the presentation of important work being done in many special fields. The program of each hospital and medical school is arranged to cover subjects in general surgery, obstetrics and gynecology, fractures and other traumas, thoracic surgery, neurosurgery, urology, orthopedic surgery, and ophthalmology and otolaryngology. Presentations of subjects under these classifications are being so correlated that the visiting surgeon will have the opportunity to devote his time continuously to clinics dealing with the specialty in which he is most interested. The daily clinical bulletin will present the program according to the above classification in order to facilitate the selection of clinics which the visiting surgeon desires to attend. The complete detailed clinical program for the succeeding day will be posted each afternoon in the form of bulletins at headquarters in the Stevens Hotel and distributed in printed form each morning.

SCIENTIFIC SESSIONS

The opening scientific session of the Clinical Congress will be held on Monday evening in the ballroom of the Stevens Hotel, when the Presidential Meeting and Convocation will be combined. The new officers of the College will be

inaugurated and the initiates received into fellowship. Distinguished surgeons from foreign countries will then be introduced, following which Dr. George P. Muller of Philadelphia, will deliver the presidential address.

Scientific meetings will be held on Tuesday, Wednesday and Thursday evenings at headquarters, and outstanding members of the profession, of national and international prominence will address the assembled guests of the Congress. The speakers and subjects of these addresses are being carefully selected to assure contributions which will be of interest to those practicing in all of the special fields of surgery. As in former years, separate scientific meetings are being arranged for Tuesday and Thursday evenings for the presentation of papers on subjects of special interest to the ophthalmologists and the otolaryngologists by surgeons who are outstanding in these fields.

Panel discussions have met with such decided success at the Clinical Congress and sectional meetings of the College, that the schedule this year will include thirty or more such conferences arranged for Monday, Tuesday, Wednesday and Thursday afternoons. Recognized authorities are co-operating with the College as leaders and collaborators of these panels and a careful selection of topics will cover pertinent subjects in all fields of surgery. This program will permit more informal discussion of these subjects than would be permitted in larger general meetings. The plan provides that the leader will present his subject within a ten-minute period, collaborators will then discuss various phases of these topics briefly after which general discussion from the floor will be encouraged.

Important features of the afternoon sessions at headquarters are () Symposium on fractures and their traumas () symposium on cancer (3) conference on graduate training for surgery.

A new feature of considerable interest to all surgeons attending the Congress will be a series of group clinical conferences which are being arranged for Friday afternoon. Ten special fields of surgery have been selected and a pertinent subject of current interest will be briefly presented in each conference. Leaders will then direct discussions from the floor and any surgeon attending the meeting will be invited to present a special problem with which he is concerned—one that is related to the special field under discussion. Recognized authorities will endeavor to answer these questions and offer as much helpful advice as possible. Everyone should benefit by participating in a consultation conference of this nature.

The Board of Regents plans to provide a varied scientific program for the 1940 Clinical Congress that will appeal to all general surgeons and also offer to those interested in the surgical specialties an opportunity to learn of the newer developments in their respective fields.

GRADUATE TRAINING IN SURGERY

The College program for graduate training in surgery will receive special attention at the Congress. There will be a session devoted to a program on this important subject which should elicit the interest of all hospital executives as well as surgeons and educators who are concerned with the future standard of surgery in the United States and Canada. Authorities will present a brief program dealing with various types of educational programs, following which there will be a general discussion from the floor. All visitors to the Congress are invited to participate in these discussions.

MEDICAL MOTION PICTURES

An enlarged program of surgical motion pictures will be presented at headquarters which will include the latest available films on a wide variety of subjects of interest to the surgeon. The schedule will be arranged so as not to conflict with either the clinical programs at the hospitals or the scientific sessions and will include both sound and silent, standard and color films which have been approved by the Committee on Medical Motion Pictures.

HOSPITAL CONFERENCE

The twenty-second annual Hospital Standardization Conference will open the Clinical Congress with a meeting at headquarters on Monday morning at 10:00 a.m. Official announcement of the 1940 approval lists of the College which deal with hospital activities will be made at this meeting. Throughout the week there will be a series of hospital meetings with practical demonstrations, panel discussions, and round table conferences, dealing with all phases of hospital administration and various problems related to management, efficiency and education in the hospital. One hospital conference will be devoted exclusively to subjects of vital interest to hospital executives and members of governing boards. At a joint session with the Association of Record Librarians of North America, the subject of medical records will receive special consideration from the standpoint of their relationship to the clinical work of the physician, and the medical and surgical specialist. There will be ample opportunity

PRELIMINARY PROGRAM FOR 1940 CLINICAL CONGRESS

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during the Congress for visitors to inspect the hospitals in Chicago and vicinity

PUBLICATION OF PROCEEDINGS

As in former years, the formal papers which are presented at the scientific sessions of the Congress will be published in a special issue of the official journal of the College, SURGERY, GYNECOLOGY, AND OBSTETRICS, in February following the meeting. This is furnished without additional charge to all Fellows, junior candidates, and others who register for the Congress as invited guests. The papers which are presented in connection with the Hospital Standardization Conference are published in subsequent issues of the *Bulletin* of the American College of Surgeons.

ADVANCE REGISTRATION

The hospitals and medical schools of the Chicago area afford accommodations for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to the number that can be comfortably accommodated at the clinics. The limit of attendance will be based on a survey determining the available facilities in the participating hospitals and schools. It is expected, therefore, that surgeons who wish to attend the Congress will register in advance. A registration fee will be required in order to provide funds with which to meet expenses of the meeting. A formal receipt will be issued to each surgeon registering in advance which will be exchanged for a general admission card upon presentation at headquarters during the Congress. This card, which is not transferable, must accompany all requests for clinic tickets and be presented for admission to the scientific sessions.

A resolution adopted by the Board of Regents provides that the registration fee for Fellows of the College and endorsed junior candidates shall be \$5.00, that no fee for the 1940 Clinical Congress shall be required of initiates (class of 1940), that the fee for surgeons who are not Fellows, attending as invited guests of the College, shall be \$10.00.

As in previous years, admission to clinics and demonstrations in the hospitals and certain of the scientific meetings at headquarters will be controlled by means of tickets. This plan provides

for the distribution of visiting surgeons at the various clinics and other meetings and helps to insure against overcrowding. The number of tickets issued for any clinic will be limited to the capacity of the room in which the clinic is held. Visiting surgeons are urged to co-operate in making the clinic ticket plan a success.

HEADQUARTERS—TECHNICAL EXHIBITION

Headquarters for the Congress will be established at the Stevens Hotel where there are unusual facilities for accommodating the Congress. All of the public rooms have been reserved for conferences, registration, ticket bureaus, clinic bulletins, executive offices and scientific exhibits. Thus, all activities of the Congress, except the clinical program, will be located under one roof.

The technical exhibition together with the registration desk will be located on the lower floor of the Stevens Hotel in the large exhibition hall. Leading manufacturers of surgical instruments and supplies, sutures, dressings, pharmaceuticals, operating room equipment, x-ray apparatus and hospital equipment of all kinds, as well as publishers of medical books will be represented in the exhibition. It will provide for the visiting surgeons an opportunity of carefully inspecting the finest modern products of all those industries which are aiding the work of the surgeon and the hospital.

CHICAGO HOTELS AND THEIR RATES

In addition to the headquarters hotel, the Stevens, there are several first-class hotels within short walking distance of headquarters, providing ample hotel facilities at reasonable rates. It is suggested that reservation of hotel accommodations be made at an early date. The following hotels are recommended by the Committee.

	Minimum Rate with Bath	
	Single	Double
Auditorium, 430 S. Michigan Ave	\$2.50	\$4.00
Bismarck, 171 W. Randolph St	3.50	5.00
Blackstone, Michigan Ave at 7th St	4.00	6.00
Congress, 500 S. Michigan Ave	3.00	5.00
Drake, Michigan and Lake Shore Drive	4.00	6.00
Harrison, 57 E. Harrison St	2.00	3.00
LaSalle, 10 N. LaSalle St	2.50	4.00
Morrison, 79 W. Madison St	2.50	4.00
Palmer House, 15 E. Monroe St	3.50	5.00
Sherman, 106 W. Randolph St	2.50	4.00
Stevens, 720 S. Michigan Ave	3.00	4.50

PRELIMINARY CLINICAL PROGRAM

COOK COUNTY HOSPITAL

Monday

OBSTETRICS AND GYNECOLOGY

- A. J. KOWAK and H. H. HILL—2. Studies in acridine and glycine.
JAMES H. BLOOMFIELD—2. Demonstration of cases. Caesarian section and local anesthesia, or management of occiput posterior.
S. J. BEVENSON—2. Cases in the prenatal clinic.
T. J. MORRIS—2. Puerperal infection.

FRACTURES AND OTHER TRAUMAS

- WILLIAM R. CYRUS, J. J. CALLAN and C. S. SCHUBERT—Operative clinic.

Tuesday

GENERAL SURGERY

- KARL A. MEYER—9. Operative clinic: Stomach and colon.
JOSEPH R. HARGER—9. Operative clinic: Peritoneal anesthesia for major operations.
C. C. GUY—9. Dry clinic: Surgical problems in the diabetic.
SEYMOUR L. KOCK—9. Dry clinic: Injuries and infections of the hand.
RAYMOND W. MCNEELY—10. Operative clinic: Gall bladder, gastric surgery.
E. M. MILLER—10. Dry clinic: Bowel obstruction in the newborn, pneumonia complicating scarlet fever, volvulus of sigmoid colon in children.
J. D. KOCKEY—9. Operative and dry clinic: Arteriovenous anastomosis of the legs.
JOSEPH B. O'DONOGHUE—10. Operative clinic: Gastro-intestinal.

OBSTETRICS AND GYNECOLOGY

- W. T. CARLISLE—9. Gynecological operations.
A. E. KANTER—9. Gynecological operations.

ORTHOPEDIC SURGERY

- ARTHUR CONLEY and DONALD MILLER—9. Operative clinic.
MARCOUS H. HOWART and FELIX JANNEY—10. Operative clinic: Shoulder injuries.

THORACIC SURGERY

- JESSE HEAD—9. Dry clinic.
R. B. REITMAN—2. Operative clinic.

OTOLARYNGOLOGY

- JACOB LEISCHNITZ—2. Operative and dry clinic.
RAYMOND W. KEENEY—2. Operative and dry clinic.

Wednesday

GENERAL SURGERY

- VICTOR L. SCHLAGER—9. Operations.
HAROLD C. VORIS—9. Dry clinic: Operative treatment of head injuries.
RALPH C. SULLIVAN—9. Operations.
EDWARD A. CHRISTOFFERSON—9. Operative clinic: Appendicitis.

- FRANK J. JIRK—9. Dry clinic: Dysenteric colitis in the male.
J. R. BOCHENBERGER—2. Operative clinic: Thyroid, biliary tract.

OBSTETRICS AND GYNECOLOGY

- HERBERT E. SCHWARTZ—9. Gynecological operations.
A. F. LASH—9. Gynecological operations.

FRACTURES AND OTHER TRAUMAS

- GORDON L. APPELBAUGH—2. Operative clinic: Fracture operation for fractured neck of femur: open reduction of the femora with intramedullary peg; reconstruction of mal-united Colles' fracture.

ORTHOPEDIC SURGERY

- PHILIP LEWIS and SIDNEY SIDENBERG—9. Operative clinic.
DANIEL H. LEVITMAN and staff—9. Dry clinic.

OPHTHALMOLOGY

- JAMES E. LEVINTHORN and WILLIAM F. MOWCHLEY—9. Operations.

OTOLARYNGOLOGY

- S. J. PEARLMAN—10. Operative and dry clinic.
JACOB LEISCHNITZ—2. Operative and dry clinic.

Thursday

GENERAL SURGERY

- RALPH C. SOLLY—9. Operative clinic.
MARSHALL D. VIDOV—9. Operative clinic: Thyroid.
RALPH B. BREITMAN—9. Operative clinic.

OBSTETRICS AND GYNECOLOGY

- E. W. FISCHER and staff—9. Gynecological operations.
J. P. GREENHILL—9. Gynecological operations.

FRACTURES AND OTHER TRAUMAS

- WILLIAM R. CYRUS and JAMES J. CALLAHAN—2. Operations.

ORTHOPEDIC SURGERY

- FRANK G. MURPHY and RALPH FISCHER—9. Operations.
E. J. BERENBERGER—9. Operations.
ARTHUR H. CONLEY and staff—10. Dry clinic.

OTOLARYNGOLOGY

- RAYMOND W. KEENEY—2. Operative and dry clinic.

Friday

GENERAL SURGERY

- LOUIS RIVER—9. Dry clinic: Abdominal incisions.
E. H. WARKENTIN—9. Operative clinic: Reconstruction treatment of burns.
J. R. BOCHENBERGER—9. Operative clinic: Gastric resection for duodenal ulcer.

OBSTETRICS AND GYNECOLOGY

- WILLIAM H. BROWN—9. Gynecological operations.
FREDERICK H. FALLS—9. Gynecological operations.
ABRAHAM DAVIS—9. Use of epinephrine in acute inversion of the uterus.

LOUIS RUDOLPH Ring dystocia constriction
 JAMES E FITZGERALD Heart disease in pregnancy
 DAVID S HILLIS Recognition of cephalopelvic disproportion
 AUGUSTA WEBSTER Vitamin K in pregnancy

ORTHOPEDIC SURGERY

FRED HARK and CLAUDE LAMBERT—9 Operations
 H KELIKIAN and GRAHAM A KERNWEIN—10 Operations

OPHTHALMOLOGY

SANFORD R. GIFFORD—9 Operations
 EDWARD A ROLING—10 Operations

OTOLARYNGOLOGY

JACOB LIFSCHUTZ, T C GALLOWAY, and R W KERWIN—
 10 Operative and dry clinic

Days to be Announced

GENITO-URINARY SURGERY

HARRY CULVER, HARRY C ROLNICK, D F RUDNICK, and
 L L VESEEN Operations

RESEARCH AND EDUCATIONAL
HOSPITALS*Wednesday*

GENERAL SURGERY

W H COLE—9 Thyroidectomy
 P W GREELEY—9 Plastic surgery

OBSTETRICS AND GYNECOLOGY

FREDERICK H FALLS and staff—1 Vaginal hysterectomy,
 cesarean section

GENITO-URINARY SURGERY

C H McKENNA—9 Operations

NEUROSURGERY

ERIC OLDBERG, PERCIVAL BAILEY, W A GUSTAFSON, and
 MILTON TINSLEY—9 Operative and dry clinic

Thursday

GENERAL SURGERY

CHARLES B PUESTOW—9 Cholecystectomy
 R B MALCOLM—9 Radical mastectomy

ORTHOPEDIC SURGERY

H B THOMAS, F W HARK, C N LAMBERT, and P H
 DUBE—1 Hip joint surgery and end results Fracture
 of neck of femur, epiphyseal separations

OPHTHALMOLOGY

HALLARD BEARD and staff—9 Operative and dry clinic.

OTOLARYNGOLOGY

F L LEDERER and staff—9 Operative and dry clinic

HENROTIN HOSPITAL

Wednesday

GENITO URINARY SURGERY

C O MILLER—9 Neoplasm of the kidneys

FRACTURES AND OTHER TRAUMAS

RALPH A KORDENAT—9 Operations
 JOHN A GRAHAM—9 Demonstration, with lantern slides
 Fracture of distal end of radius

ST LUKE'S HOSPITAL

Tuesday

GENERAL SURGERY

W R CUBBINS—9 Operations
 GEZÁ DE TAKATS—9 Operative clinic Lumbar sympathectomy
 SELIM W McARTHUR—9 Operations
 Staff—9 Dry clinic
 E C HOLMBLAD and R A JACOBSON Treatment of
 gas gangrene
 T L HANSEN and DR JENSEN Shelf fractures of tibia
 JOHN ELLIS Amputations
 G V PONTIUS Hypertrophic pyloric stenosis in the
 adult
 GEZÁ DE TAKATS and J T REYNOLDS Indications and
 results of sympathectomy in Buerger's disease
 H I MEYER Paget's disease, osteitis deformans

OPHTHALMOLOGY

ELMER VORISEK—2 Demonstration of cases

Wednesday

GENERAL SURGERY

PAUL GREELEY—9 Operative clinic Plastic surgery
 H E MOCK—9 Operations
 Staff—9 Dry clinic
 SELIM W McARTHUR Stomach deformities simulating
 malignancy in their x-ray study
 F L McMILLAN Lesions of the colon
 H E MOCK Breast tumors, malignancies and granulo-
 mas of the gastro intestinal tract, pancreatitis
 H. E JONES Treatment of complete biliary fistulas
 E LEE STROHL Common duct obstructions
 W G DIFFENBAUGH Autoplastic operation for hernial
 repair, statistical report.

ORTHOPEDIC SURGERY

HENRY B THOMAS—9 Bone changes in connection with
 thyroid disease
 FRED W HARK—9 Bone changes in connection with
 sickle cell anemia.
 CLAUDE N LAMBERT—9 Bone tumors
 HARRY E MOCK, ALVIN R MORROW, CHARLES E SHAN-
 NON, JOHN L LINDQUIST, and DONNELL C HOWE—10
 Operative and dry clinics Conservative treatment of
 fractures of neck of the femur, supracondylar fractures
 of humerus, malunited fractures of the ankle
 JOHN D ELLIS—10 Compression fractures of vertebrae
 using Ryerson hyperextension device
 EDWIN W RYERSON—1 30 Operative clinic Shelf opera-
 tion at the hip, reconstruction of hip joint, osteotomy
 to produce back-knee
 FREMONT A CHANDLER—2 Operative clinic Aseptic
 necrosis of head of femur
 ROBERT E RITTER—2 30 Arthroplasty
 HAROLD A SOFIELD—3 Discussion of leg lengthening
 operations, indications and technique
 Open forum—3 30

Thursday

OBSTETRICS AND GYNECOLOGY

Staff—9 Operations

GENITO-URINARY SURGERY

L L SCHMIDT and staff—9 Operative and dry clinic.

OPHTHALMOLOGY

E. V. L. BROW—*g.* Demonstration of cases
FRANK BRAWLEY and JAMES W. CLAR —*a.* Demonstration
of cases.

Friday

OPHTHALMOLOGY

RICHARD GAMBLE—*g.* Demonstration of cases.

Days to be Announced

FRACTURES AND OTHER TRAUMAS

H. E. MOCK and staff. Skull fractures.
W. R. CURRIER. Abdominal injuries.
ERIC OLDENBERG. Spinal injuries.
GEORGE DE TAKAT. Circulation and trauma.
E. W. RYERSON. Conservative treatment of fractures.
HAROLD SOWFIELD. Fractures of the femoral neck.
P. W. GRIELEY. Plastic repair of cutaneous defects.
T. P. GR. UEL. Injuries of the genito-urinary tract.
A. P. SOLOMON. The psychic aspect of injuries.

OTOLARYNGOLOGY

HORACE R. LYONS, WALTER H. TREGGARD and staff—
Operative and dry clinic. Sulfanilamide therapy in acute
mastoiditis and acute otitis media. Protons treatment for
sinusitis.
PAUL H. HOLDSNER and ALBERT H. ANDREWS, J. —
Peroral endoscopy: clinical presentation of bronchial
and esophageal cancer.

MERCY HOSPITAL

Days to be Announced

GENERAL SURGERY

M. MCGUIRE—*g.* Operative and dry clinic. Biliary tract.
L. D. MCKENZIE—*g.* Operative and dry clinic. Thyroid
WILLIAM PICKETT—*g.* Operative and dry clinic. Gastric
surgery.
C. F. SAWYER—*g.* Intestinal obstruction.
J. SANDY and JOHN SACKERAY—*g.* Tests for liver function.
A. K. VATCHER—*g.* Treatment of varicose veins and ulcers.

OBSTETRICS AND GYNECOLOGY

HERBERT SCHMIDT and staff—*g.* Operative and dry clinic.
Vaginal hysterectomy; Watkins transposition operation,
Manchester Fothergill operation for vaginal plastic
anterior colporrhaphy and perineorrhaphy. LaForte
colpocleisis.

GENITO-URINARY SURGERY

H. E. LAYNES—*g.* Clinical cystometry as aid in the diag-
nosis of disturbances of micturition.

NEUROSURGERY

HAROLD C. VORIS—*g.* Dry clinic. Protruding intervertebral
disc.

OPHTHALMOLOGY

CARL SCHRAUB and L. G. HOFFMAN—*g.* Operative and dry
clinic. Demonstration of verified cases of optochiasm-
atic aneurysm.

OTOLARYNGOLOGY

PETER P. LEIDENKAMP—*g.* Disturbances of equilibrium.
CARL CHRISTOFF—*g.* Laryngeal malignancies.
HERBERT NASH—*g.* Endonasal operations.
G. T. JORDAN—*g.* Anatomy of the temporal bone.

MICHAEL REESE HOSPITAL

Monday

GENERAL SURGERY

JAMES PANEJL. Gastro-intestinal operations.
ALFRED A. STRAUSS and SEIGFRIED STRAUSS. Gastro-intest-
inal operations.
Staff. Operative and dry clinics. Gastro-intestinal surgery.
faciomaxillary surgery.

OBSTETRICS AND GYNECOLOGY

Staff. Gynecological operations.

ORTHOPEDIC SURGERY

Staff. Dry clinics.

Tuesday

GENERAL SURGERY

R. B. BITTM and DR. T. VICKENBACH. Gall-bladder
operations.
M. L. PARKER. Gastro-intestinal operations.
Staff. Operative and dry clinics. Gall-bladder disease.

OBSTETRICS AND GYNECOLOGY

Staff. Dry clinics.

ORTHOPEDIC SURGERY

Staff. Operations.
D. H. LEVITZMAN. Knee joint surgery.

Wednesday

GENERAL SURGERY

D. C. STRAUSS. Thyroid operations.
V. CROWN. Hernia operations.
Staff. Operative and dry clinics. Thyroid surgery.

GENITO-URINARY SURGERY

Staff. Operative and dry clinics.

Thursday

GENERAL SURGERY

ALFRED A. STRAUSS and SEIGFRIED STRAUSS. Gastro-
intestinal operations.
M. FELLLOW. Peripheral vascular surgery.
Staff. Operative and dry clinics. Peripheral vascular
disease, blood transfusions.

OBSTETRICS AND GYNECOLOGY

Staff. Gynecological operations.

NEUROSURGERY

ADRIEN VERHOOGHE—*g.* Dry clinic. Cerebellar tumors
in children.
ADRIEN VERHOOGHE— Operations.

Friday

GENERAL SURGERY

L. ZIEGLERMAN. Hernia operations.
S. GOLDBERG. Abdominal operations.

GENITO-URINARY SURGERY

Staff. Operative and dry clinics.

ORTHOPEDIC SUR

Staff. Operations.

THORACIC SURGERY

R. B. BITTM and DR. T. VICKENBACH. Operations.

CHICAGO MEMORIAL HOSPITAL

Monday

GENERAL SURGERY

PETER S CLARK, CHARLES J DRUECK, ROBERT A MELENDY, BENNETT R PARKER, JOHN VAN PROHASKA, M L WEINSTEIN, LEO M ZIMMERMAN, and GEORGE M LANDAU—1 Operative and dry clinic
 JOHN VAN PROHASKA Surgical aspects of carcinoma of ampulla of Vater, enterogenous cysts in infants
 M L WEINSTEIN Resection of stomach without clamps, rectal anesthesia
 LEO M ZIMMERMAN Essential problems in the surgical treatment of inguinal hernia
 BENNETT R PARKER Problems in gall-bladder surgery

Tuesday

FRACTURES AND OTHER TRAUMAS

T C BROWNING, EDWARD L COMPERE, ARTHUR H CONLEY, EMILE C DUVAL, C R G FORRESTER, A H MASON, FRED M MILLER, S PERRY ROGERS, HORACE STIMSON, and GEORGE M LANDAU—9 Operative and dry clinic
 C R G FORRESTER Shoulder fractures
 A H MASON Fractures of the scaphoid
 FRED M MILLER and T C BROWNING Fractures of foot and ankle
 EDWARD L COMPERE Vitamin D and calcium in fracture repair
 S PERRY ROGERS Vitallium in fractures
 EMILE C DUVAL Internal semilunar cartilage as a factor in industrial surgery
 HORACE STIMSON Treatment of fractures of spine

OPHTHALMOLOGY

FRANCIS M CRAGE, HERMAN P DAVIDSON, and GLENWAY NETHERCUT—2 Operative and dry clinic

OTOLARYNGOLOGY

OSCAR CLEFF, ALFRED LEWY, ROBERT LEWY, JAMES B McBEAN, GORDON H SCOTT, and RICHARD W WATKINS—2 Operations

Wednesday

GENERAL SURGERY

Medical, surgical, x ray and pathological departments—2
 Symposia Treatment of pneumonia with serum and sulfapyridine, peptic ulcer

OBSTETRICS AND GYNECOLOGY

HARRY B W BENARON, JAMES E FITZGERALD, WILLIAM F HEWITT, GEORGE N SCHIFF, BEATRICE E TUCKER, and HARRY L MEYERS—9 Operative and dry clinic
 HARRY B W BENARON Presacral block in obstetrics
 GEORGE N SCHIFF Obstetrical analgesia
 JAMES E FITZGERALD Effect of Vitamin K in labor
 BEATRICE E TUCKER and HARRY L MEYERS Manchester anterior colporrhaphy and perineorrhaphy

Thursday

GENERAL SURGERY

CASPER M EPSTEIN—0 Operative clinic Correction of cleft palate, facial plastic

GENITO-URINARY SURGERY

VINCENT J O'CONOR, JOHN P O'NEIL, J WILLIAM PARKER, and KENNETH SOKOL—9 Operative and dry clinic

EVANSTON HOSPITAL

Tuesday

GENERAL SURGERY

W R PARKES, FREDERICK CHRISTOPHER, W KENNETH JENNINGS, JAMES M GRIER, and J E KEARNS—9 Operations

OBSTETRICS AND GYNECOLOGY

W C DANFORTH, R M GRIER, HOWARD J HOLLOWAY, P H SMITH, and C H GALLOWAY—9 Operations

GENITO-URINARY SURGERY

JAMES I FARRELL—9 Operations

FRACTURES AND OTHER TRAUMAS

MARCUS H HOBART and DWIGHT T CLARK—9 Operations

ORTHOPEDIC SURGERY

R C LONERGAN—9 Operations

THORACIC SURGERY

JEROME R HEAD—9 Operations

OPHTHALMOLOGY

G R SOPER—9 Operations

OTOLARYNGOLOGY

T C GALLOWAY and H C BALLENGER—9 Operations

ALBERT MERRITT BILLINGS HOSPITAL

Tuesday

GENERAL SURGERY

L R DRAGSTEDT and HILGER P JENKINS—9 Operative and dry clinic

Wednesday

GENITO URINARY SURGERY

CHARLES B HUGGINS—9 Operative and dry clinic

Thursday

ORTHOPEDIC SURGERY

CLY H HATCHER and DALLAS B PHENISTER—9 Operative and dry clinic

Friday

GENERAL SURGERY

ALEXANDER BRUNSCHWIG and WILLIAM E ADAMS—9 Operative and dry clinic

CHICAGO LYING-IN HOSPITAL

Thursday

OBSTETRICS AND GYNECOLOGY

FRED L ADAIR and staff—9 Operations Cesarean section, hysterectomy, etc Dry clinics Manikin demonstration, delivery room technique, etc

PRESBYTERIAN HOSPITAL

Tuesday

OBSTETRICS AND GYNFCOLOGY

N. SPROAT HEANEY, EDWARD ALLEN, FRED O. PRIEST,
H. RAY BOTTEN and ARON E. KANTER—*g.* Operative
and dry clinic.

Wednesday

GENERAL SURGERY

VICTOR C. D. VID, KELLOGG SPEED, HARRY A. OVER,
WELDON EDWIN M. MILLER, CARL B. D. VID, ALBERT
H. MONTGOMERY and R. E. GILCHRIST—*g.* Operative
and dry clinic.

Thursday

GENITO-URINARY SURGERY

HERM V. L. KRETZSCHMAR, ROBERT H. HERBERT, NORMAN J.
H. CREE, and JAMES W. MERRICK—*g.* Operative and
dry clinic.

MT SINAI HOSPITAL

Friday

GENERAL SURGERY

D. A. WILLES—*g.* New type of hernioplasty
E. I. GRUBER—*g.* Operative clinic.
V. L. SCHLESINGER and staff—*g.* Hernioplasty
A. A. STRAUSS and S. STRAUSS—*g.* Surgery of the colon.
M. R. GUTTMAN—*g.* Plastic surgery of the nose.
J. LEIBOWITZ—*g.* Endoscopy
EMIL ARON—*g.* Oral surgery
J. M. MORA—*g.* Thyroidectomy

OBSTETRICS AND GYNFCOLOGY

A. E. KANTER and LOUIS RUDOLPH. Gynecological opera-
tions.
A. F. LAMB. Vaginal hysterectomy
H. BUCK, CH. C. NEWBURGER, and A. H. GOSWAMI. Ob-
stetrical clinic.

GENITO-URINARY SURGERY

H. C. ROLNICK—*g.* Operations

ORTHOPEDIC SURGERY

C. L. JACOBI and LEO MILLER—*g.* Operations.

OTOLARYNGOLOGY

S. MORWILL—*g.* Operations.

ST MARY OF NAZARETH HOSPITAL

Days to be Announced

GENERAL SURGERY

GEORGE M. MUELLER, A. SANFORDICK, E. WARRICKWELL,
and T. STEINKERT. Operative clinic.
T. LARKOWSKEL. Operative clinic. Paravertebral anesthesia

OBSTETRICS AND GYNFCOLOGY

M. UMANSKI. Operations

ORTHOPEDIC SURGERY

L. CRAJA. Operations.

OTOLARYNGOLOGY

F. PRZYKREWICKI. Otolaryngological operations.

WESLEY MEMORIAL HOSPITAL

Tuesday

GENERAL SURGERY

R. W. McNEALY—*g.* Operative and dry clinic.

OBSTETRICS AND GYNFCOLOGY

CHARLES B. REED—*g.* Operative and dry clinic.

GENITO-URINARY SURGERY

VICTOR D. LEEPERHAME—*g.* Operative and dry clinic.

ORTHOPEDIC SURGERY

PHILIP H. KREIBERGER—*g.* Operative and dry clinic.

THORACIC SURGERY

CARL O. LATIMER—*g.* Operative and dry clinic.

OPHTHALMOLOGY

WILLIAM A. MANN—*g.* Operative and dry clinic.

OTOLARYNGOLOGY

THOMAS P. O'CONNOR—*g.* Operative and dry clinic.

NORWEGIAN AMERICAN HOSPITAL

Thursday

GENERAL SURGERY

J. M. ANDERSON—*g.* Postoperative intravenous modifi-
cation.
G. B. F. GLEY—*g.* Surgical physiology of the thyroid.
A. M. JENSEN—*g.* Surgical physiology of the thyroid.
J. R. GUNDERSON—*g.* Technique of thyroidectomy.
F. H. FOWLER, JR.—*g.* Time question in appendicitis.
J. V. FOWLER, JR.—*g.* Pre-operative and postoperative
care of the thyroid patient.
J. E. VERHAAG—*g.* Hernia from industrial causes.
M. M. Corbett—*g.* Immediate treatment of abdominal
injuries.
W. JOHNSON—*g.* Carcinoma of the stomach.
F. M. NICHOLSON—*g.* Treatment of scalp injuries.
M. E. LARSEN—*g.* Technique of cholecystec-
tomy.
J. V. FOWLER, JR.—*g.* Carcinoma of the breast.

OBSTETRICS AND GYNFCOLOGY

B. W. BRISTON—*g.* Indications for cesarean section.
P. F. BRISTON—*g.* Differential diagnosis of uterine tumors.

GENITO-URINARY SURGERY

D. F. RUDOLPH—*g.* Electrical resection of the prostate.

FRACTURES AND OTHER TRAUMAS

H. A. SCHILD—*g.* Steel pin fixation of fractures of neck
of the femur.

OTOLARYNGOLOGY

M. A. GLATT—*g.* Control of hemorrhage in tonsillectomy.
J. W. HARRIS—*g.* Danger signals in mastoid infection.

MOTHER CABRINI MEMORIAL HOSPITAL

Wednesday

GENERAL SURGERY

S. CHESROW and staff—*g.* Abdominal operations.

PASSAVANT MEMORIAL HOSPITAL

Thursday

GENERAL SURGERY

- JOHN A. WOLFER and associates—9 Tumor clinic
 FRANK QUEEN The surgeon and pathologist as a diagnostic team, i. e., the decision for and conduct of the biopsy, with illustrative cases
 EARL BARTH Preliminaries that must not be forgotten prior to beginning x ray therapy
 H. E. DAVIS The selection of tumor cases and x ray vs radium therapy
 HENRY JAFFE How much radiation therapy should malignant tumors receive? How should it be administered?
 FRED MERRIFIELD Surgical results with intra-oral cancers
 J. M. GREENE Useful aids in the differential diagnosis of tumors of the neck
 JOHN MOHARDT Our results with cancer of the breast
 E. M. SMITH, JR. Results with treatment of unusual cutaneous tumors
 JOHN DELPH Cancer of the larynx
 L. L. VESEEN The treatment of cancer of the male genitalia
 GEORGE GARDNER The treatment of cancer of the female genitalia
 HERMAN CHOR The psychiatrist's part in a tumor clinic, illustrative cases
 EARL BARTH Tour of radiation therapy department of Northwestern University Medical School

Days to Be Announced

GENERAL SURGERY

- J. R. BUCHBINDER. Presentation of cases illustrating gastric and thyroid surgery
 SUMNER L. KOCH, MICHAEL L. MASON, and HARVEY ALLEN Problems in surgery of the hand.

OBSTETRICS AND GYNECOLOGY

- ARTHUR H. CURTIS, GEORGE H. GARDNER and associates Integration of newer anatomical studies with clinical gynecology
 DAVID HILLIS and associates Presentation of obstetrical problems

ORTHOPEDIC SURGERY

- PAUL B. MAGNUSON, JAMES K. STACK, and FRANK E. STACHFIELD Cases illustrating results of joint debridement
 EMIL HAUSER Presentation of cases showing end results in certain orthopedic procedures

NEUROSURGERY

- LOYAL DAVIS and JOHN MARTIN Presentation of cases

GENITO URINARY SURGERY

- L. W. RIBA. Female urethritis, case presentations

OPHTHALMOLOGY

- SANFORD GIFFORD and associates Presentation of problems

OTOLARYNGOLOGY

- JOHN F. DELPH and associates. Presentation of cases

ILLINOIS EYE AND EAR INFIRMARY

Monday

OTOLARYNGOLOGY

- SAMUEL SALINGER—2 Operative and dry clinic Plastic surgery about the nose

Tuesday

OPHTHALMOLOGY

- THOMAS D. ALLEN, V. M. LEECH, and G. W. NETHERCUT—2 Operative clinic Cataracts, ptosis, glaucoma

OTOLARYNGOLOGY

- PHILIP O'CONNOR—0 Plastic surgery, demonstration of patients, lantern slides, etc
 CARL CHRISTOPH—9 Operative clinic Radical mastoid
 E. J. BLONDER—2 Labyrinthine diagnosis and demonstration of the galvanic following reaction
 M. A. GLATT—2 Operative clinic Radical mastoid and external frontal

Wednesday

OPHTHALMOLOGY

- PETER KRONFELD—9 Gonioscopy
 KATHARINE CHAPMAN—9 Orthoptic clinic
 ROBERT VON DER HEYDT—3 Slit lamp demonstration

OTOLARYNGOLOGY

- DR. WOODRUFF—Laryngeal sinus and ear cases, endoral mastoid and sinus surgery
 PHILIP O'CONNOR—2 Operative clinic

Thursday

OPHTHALMOLOGY

- LOUIS G. HOFFMAN—9 Operative and dry clinic Verhoeff suture
 E. K. FINDLAY—10 Dry clinic
 E. K. FINDLAY—2 Operative clinic

OTOLARYNGOLOGY

- E. J. BLONDER—9 Operative and dry clinic Radical mastoid
 M. A. GLATT—2 Osteomyelitis of the frontal bone

Friday

OPHTHALMOLOGY

- PETER KRONFELD—9 Gonioscopy
 KATHARINE CHAPMAN—9 Orthoptics
 SAMUEL J. MEYER—2 Operative clinic Cataracts, glaucoma

OTOLARYNGOLOGY

- ALFRED LEWY—2 Operative clinic

WOMEN AND CHILDREN'S HOSPITAL

Wednesday

OBSTETRICS AND GYNECOLOGY

- AMELIA GIRYOTAS, LLOISE PARSONS, PEARL STETLER, MARY EDITH WILLIAMS, and MAUDE HALL WINNETT—9 Surgical and gynecological operations
 BEATRICE TUCKER—9 Operations
 BERTHA VAN HOUSEN—9 Demonstration Teaching gynecology by models.

PRESBYTERIAN HOSPITAL

Tuesday

OBSTETRICS AND GYNECOLOGY

N. SPROAT HEARNY, EDWARD ALLEN, FRED O. PRIEST, HARRY BOTNEY and ARON E. KANTER—g. Operative and dry clinic.

Wednesd y

GENERAL SURGERY

VERNON C. D. VID, KELLOGG SPEED, HARRY A. OBER, HELMAN EDWIN, M. MILLER, CARL B. D. VID, ALBERT H. MONTGOMERY and R. K. GILCHRIST—g. Operative and dry clinic.

Thursday

GENITO-URINARY SURGERY

HERMAN L. KRETSCHMER, ROBERT H. HERNST, NORMAN J. HICKELL, and JAMES W. MERRICK—g. Operative and dry clinic.

MT SINAI HOSPITAL

Friday

GENERAL SURGERY

D. A. WILLIS—g. New type of hernioplasty.
E. I. GREENE—g. Operative clinic.
V. L. SCHLAGER and staff—g. Hernioplasty.
A. A. STRAUSS and S. STR. URS—g. Surgery of the colon.
M. R. GUTTMAN—g. Plastic surgery of the nose.
J. LEISCHUTZ—g. Endoscopy.
EUGEN ALBON—g. Oral surgery.
J. M. MOHR—g. Thyroidectomy.

OBSTETRICS AND GYNECOLOGY

A. E. KANTER and LOUIS RUDOLPH. Gynecological operations.
A. F. LAMB. Vaginal hysterectomy.
H. BUCKBAUM, C. NEWBURGER, and A. H. GOLDFINE. Obstetrical clinic.

GENITO-URINARY SURGERY

H. C. BALLOCK—g. Operations.

ORTHOPEDIC SURGERY

C. L. JACOB and LEO MILLER—g. Operations.

OTOLARYNGOLOGY

S. MORWITZ—g. Operations.

ST MARY OF NAZARETH HOSPITAL

Days to be Announced

GENERAL SURGERY

GEORGE M. MUELLER, A. SAMPOLDSKI, E. WARREN SKI, and T. STEIGERT. Operative clinic.
T. LANKOWSKI. Operative clinic. Paracutaneous anesthesia.

OBSTETRICS AND GYNECOLOGY

M. UENAKIEL. Operations.

ORTHOPEDIC SURGERY

L. CRAJA. Operations.

OTOLARYNGOLOGY

F. PRZETWICKI. Otolaryngological operations.

WESLEY MEMORIAL HOSPITAL

Tuesday

GENERAL SURGERY

R. W. MCNEALY—g. Operative and dry clinic.

OBSTETRICS AND GYNECOLOGY

CHARLES B. REED—g. Operative and dry clinic.

GENITO-URINARY SURGERY

VICTOR D. LEIPENBERG—g. Operative and dry clinic.

ORTHOPEDIC SURGERY

PHILIP H. KRETSCHMER—g. Operative and dry clinic.

THORACIC SURGERY

EARL O. LATIMER—g. Operative and dry clinic.

OPHTHALMOLOGY

WILLIAM A. MANN—g. Operative and dry clinic.

OTOLARYNGOLOGY

THOMAS P. O'CONNOR—g. Operative and dry clinic.

NORWEGIAN AMERICAN HOSPITAL

Thursday

GENERAL SURGERY

J. M. ANDERSON—g. Postoperative intravenous medication.
G. B. FAULKNER—g. Surgical physiology of the thyroid.
A. M. JENSEN—g. 30. Salvarsan in general surgery.
J. R. OERSTEDT—g. Technique of thyroidectomy.
P. H. FOWLER—g. 30. Time question in appendicitis.
J. V. FOWLER, JR.—g. 30. Pre-operative and post-operative care of the thyroid patient.
J. E. VERHAEGE—g. 30. Herule from industrial causes.
M. M. CORBETT—g. 30. Immediate treatment of abdominal injuries.
W. JOHNSON—g. 30. Carcinoma of the stomach.
F. M. NICHOLSON—g. Treatment of scalp injuries.
M. E. LICHTENSTEIN—g. 30. Technique of cholecystectomy.
J. V. FOWLER, JR.—g. 30. Carcinoma of the breast.

OBSTETRICS AND GYNECOLOGY

B. W. BREXTER—g. Indications for cesarean section.
P. F. SYDNER—g. Differential diagnosis of uterine tumors.

GENITO-URINARY SURGERY

D. F. RUSCHKE—g. 30. Electrical resection of the prostate.

FRACTURES AND OTHER TRAUMAS

H. A. SOWFIELD—g. 30. Steel pin fixation of fractures of neck of the femur.

OTOLARYNGOLOGY

M. A. GRANT—g. Control of hemorrhage in tonsillectomy.
J. W. HARNED—g. 30. Danger signals in mastoid infection.

MOTHER CABRINI MEMORIAL HOSPITAL

Wednesday

GENERAL SURGERY

E. CHESLOW and staff—g. Abdominal operations.

PASSAVANT MEMORIAL HOSPITAL

Thursday

GENERAL SURGERY

- JOHN A. WOLFER and associates—9 Tumor clinic
 FRANK QUEEN The surgeon and pathologist as a diagnostic team, i.e., the decision for and conduct of the biopsy, with illustrative cases
 EARL BARTH Preliminaries that must not be forgotten prior to beginning x ray therapy
 H. E. DAVIS The selection of tumor cases and x ray vs radium therapy
 HENRY JAFFE How much radiation therapy should malignant tumors receive? How should it be administered?
 FRED MERRIFIELD Surgical results with intra-oral cancers
 J. M. GREENE Useful aids in the differential diagnosis of tumors of the neck
 JOHN MOHARDT Our results with cancer of the breast
 E. M. SMITH, JR Results with treatment of unusual cutaneous tumors
 JOHN DELPH Cancer of the larynx
 L. L. VESEEN The treatment of cancer of the male genitalia
 GEORGE GARDNER The treatment of cancer of the female genitalia
 HERMAN CHOR The psychiatrist's part in a tumor clinic, illustrative cases
 EARL BARTH Tour of radiation therapy department of Northwestern University Medical School

Days to Be Announced

GENERAL SURGERY

- J. R. BUCHBINDER. Presentation of cases illustrating gastric and thyroid surgery
 SUMNER L. KOCH, MICHAEL L. MASON, and HARVEY ALLEN Problems in surgery of the hand

OBSTETRICS AND GYNECOLOGY

- ARTHUR H. CURTIS, GEORGE H. GARDNER and associates Integration of newer anatomical studies with clinical gynecology
 DAVID HILLIS and associates Presentation of obstetrical problems

ORTHOPEDIC SURGERY

- PAUL B. MAGNUSON, JAMES K. STACK, and FRANK L. STINCHFIELD Cases illustrating results of joint débride ment
 EMIL HAUSER Presentation of cases showing end results in certain orthopedic procedures

NEUROSURGERY

- LOYAL DAVIS and JOHN MARTIN Presentation of cases

GENITO-URINARY SURGERY

- L. W. RIBA. Female urethritis, case presentations

OPHTHALMOLOGY

- SANFORD GIFFORD and associates Presentation of problems

OTOLARYNGOLOGY

- JOHN F. DELPH and associates Presentation of cases

ILLINOIS EYE AND EAR INFIRMARY

Monday

OTOLARYNGOLOGY

- SAMUEL SALINGER—2 Operative and dry clinic Plastic surgery about the nose

Tuesday

OPHTHALMOLOGY

- THOMAS D. ALLEN, V. M. LEECH, and G. W. NETHERCUT—2 Operative clinic Cataracts, ptosis, glaucoma

OTOLARYNGOLOGY

- PHILIP O'CONNOR—9 Plastic surgery, demonstration of patients, lantern slides, etc
 CARL CHRISTOPH—9 Operative clinic Radical mastoid
 E. J. BLONDER—2 Labyrinthine diagnosis and demonstration of the galvanic following reaction
 M. A. GLATT—2 Operative clinic Radical mastoid and external frontal

Wednesday

OPHTHALMOLOGY

- PETER KRONFELD—9 Gonioscopy
 KATHARINE CHAPMAN—9 Orthoptic clinic
 ROBERT VON DER HEYDT—3 Slit lamp demonstration

OTOLARYNGOLOGY

- DR. WOODRUFF—Laryngeal sinus and ear cases, endoral mastoid and sinus surgery
 PHILIP O'CONNOR—2 Operative clinic

Thursday

OPHTHALMOLOGY

- LOUIS G. HOFFMAN—9 Operative and dry clinic Verhoeff suture
 E. K. FINDLAY—10 Dry clinic.
 E. K. FINDLAY—2 Operative clinic

OTOLARYNGOLOGY

- E. J. BLONDER—9 Operative and dry clinic Radical mastoid
 M. A. GLATT—2 Osteomyelitis of the frontal bone

Friday

OPHTHALMOLOGY

- PETER KRONFELD—9 Gonioscopy
 KATHARINE CHAPMAN—9 Orthoptics
 SAMUEL J. MEYER—2 Operative clinic Cataracts, glaucoma

OTOLARYNGOLOGY

- ALFRED LEWY—2 Operative clinic

WOMEN AND CHILDREN'S HOSPITAL

Wednesday

OBSTETRICS AND GYNECOLOGY

- AMELIA GRYOTAS, ELOISE PARSONS, PEARL STETLER, MARY EDITH WILLIAMS, and MAUDE HALL WINNETT—9 Surgical and gynecological operations
 BEATRICE TUCKER—9 Operations
 BERTHA VAN HOENSEN—9 Demonstration Teaching gynecology by models

VETERANS ADMINISTRATION FACILITY

Wednesday

GENERAL SURGERY

- B. F. WARD—*g.* Operations.
 R. B. MORELAND—*g.* Operative clinic: Tumors.
 A. E. WILLIAMS—*g.* Inspection of deep vein and radium unit.
 G. R. ALLABEN—*ro.* Dry clinic: Diagnosis and treatment of certain types of malignant disease.
 MAX CUTLER—*g.* Intra-oral and laryngeal malignancies.

GENITO-URINARY SURGERY

- T. O. McDOUGALL—*g.* Operations.

THORACIC SURGERY

- JEROME R. HEAD—*g.* Dry clinic: Thoracoplasties.

ILLINOIS MASONIC HOSPITAL

Thursday

GENERAL SURGERY

- H. W. MILLER and WALTER C. BORNHEIMER—*g.* Use of the peritoneoscope.
 C. J. D. UICK, Sr. and H. E. OLIVER—*g.* Colon operation.
 T. G. WALLER—*g.* Gall-bladder surgery.
 R. B. MALCOLM—*g.* Surgery of the neck.
 W. B. GERRARD—*g.* Gastric surgery.

OBSTETRICS AND GYNECOLOGY

- F. O. BOWE and BEULAH WALLY—*g.* Obstetrical clinic.

GENITO-URINARY SURGERY

- C. O. REICH and C. C. SAKLAW—*g.* Operations.
 EDWARD WHITE and CHARLES MURRY—*g.* Prostatectomy, prostatic surgery.

ORTHOPEDIC SURGERY

- WALTER R. FISCHER and CHARLES N. PEASE—*g.* Clinic.

THORACIC SURGERY

- MIRIAM J. ANDERSON and W. L. KIRBY—*g.* Chest surgery.
 MIRIAM JOHNSON and LOUIS J. MILLER—*g.* Monoclonal drainage; extrapleural pneumonolysis; phrenic neurectomy; anterior thoracoplasty.
 LOUIS J. MILLER—*g.* Surgical aspects of pulmonary abscesses, primary carcinoma of lungs, diagnostic and surgical aspects.

OTOLARYNGOLOGY

- M. H. COTTE and A. H. GERRER—*g.* Mastoid operation.
 A. H. GERRER, M. H. COTTE and H. E. T. VICK—*g.* Local and general anesthesia in ear, nose and throat surgery.

JACKSON PARK HOSPITAL

Wednesday

GENERAL SURGERY

- C. C. CLARK—*g.* Abdominal operations.
 A. RAMBERGER—*ro.* Abdominal and thyroid operations.
 H. H. COX—*g.* Operative and dry clinic.

FRACTURES AND OTHER TRAUMAS

- F. G. MURPHY—*g.* Operations.

OTOLARYNGOLOGY

- NOAH FOX—*g.* Operations.

MUNICIPAL TUBERCULOSIS
SANTARIUM

Tuesday

GENERAL SURGERY

- CLYDE W. MARTY—*g.* Anorectal tuberculosis.

Wednesday

GENITO-URINARY SURGERY

- DORRIS REYNOLDS—*g.* Genito-urinary tuberculosis.

Thursday

GENERAL SURGERY

- RICHARD D. BROW—*g.* Surgical treatment of tuberculosis.

OTOLARYNGOLOGY

- GEORGE HOLMES—*g.* Bronchoscopy in tuberculosis.

Friday

THORACIC SURGERY

- MIRIAM JOHNSON—*g.* Collapse therapy clinic.

HOLY CROSS HOSPITAL

Days to Be Announced

GENERAL SURGERY

- V. F. TOMCZYK—*g.* Blood pressure and spinal anesthesia—study of two cases.
 J. B. KARR—*g.* Injection treatment of hernia: herniotomy.
 F. F. FRAIDER and N. B. P. VLETHIC—*g.* Indirect inguinal hernia.
 F. SALLETTA—*g.* Thyroidectomy.
 M. BADENIEHOWSKI—*g.* Thyroidectomy.
 J. F. RUCIC and D. S. DUCINO—*g.* Hernioplasty: vaginal hysterectomies, cholecystectomy, common duct exploration, thyroidectomy.

OBSTETRICS AND GYNECOLOGY

- P. E. LAWLER—*g.* Manilla demonstration.
 F. F. FRAIDER and N. B. P. VLETHIC—*g.* Hysterectomy.
 F. SALLETTA—*g.* Hysterectomy.

ORTHOPEDIC SURGERY

- C. P. GALANTI—*g.* Rare bone tumors.

WASHINGTON BOULEVARD HOSPITAL

Tuesday

FRACTURES AND OTHER TRAUMAS

- ARTHUR R. METZ—*g.* Operative and dry clinic.

Wednesday

OBSTETRICS AND GYNECOLOGY

- P. UL FOT—*g.* Operations.

Thursday

GENITO-URINARY SURGERY

- VINCENT J. O'CONNOR—*g.* Operations.

ST BERNARD'S HOSPITAL

Wednesday

GENERAL SURGERY

- WILLIAM G. EPSTEIN—g. Thyroid operations.
 L. B. DOWKLE, G. COHENCO, and WILLIAM McILHOLLAND—
 g. Abdominal operations.
 S. GOVERNALE—g. Dry clinic: Pseudohypertrophic mus-
 cular dystrophy.

GENITO-URINARY SURGERY

- A. J. SULLIVAN—g. Prostatic operations.

OPHTHALMOLOGY

- C. P. SULLIVAN—Cataract operations.

ALEXIAN BROTHERS HOSPITAL

Thursday

GENERAL SURGERY

- WILLIAM J. SWIFT—g. Herniotomy.
 D. VIEL MURPHY—g. Circulatory disturbances of lower
 extremity.
 FREDERICK A. RETTIG—g. Abdominal surgery and post
 operative care.

GENITO-URINARY SURGERY

- JULIUS M. GLASSER—g. Prostatectomy cases.
 EDWARD F. HARRIS—g. Dry clinic: Nephrotomy; cystoscopy
 and pyelography.
 EDWARD W. WHITE—ro. Prostatic electroresection
 urethral stone.

- A. J. WOODHULL—ro. Prostatic electroresection; fulgura-
 tion of bladder tumor, cases.

ORTHOPEDIC SURGERY

- GEORGE L. APPELBAUM— Demonstration of extirpa-
 tion for lower back pain. amputation of neck of femur.

THORACIC SURGERY

- MIRAS JOAQUINES and LOUIS J. MILLER—g. Operath
 clinic. First-stage thoracoplasty; extrapleural pneu-
 molysis, auxiliary approach; lobectomy for bronchiectasis.
 Dry clinic. Haddad's syndrome, clinical and radiological
 aspects, chronic suppuration of the lung in relation to
 carcinoma of the lung.

AUGUSTANA HOSPITAL

Tuesday

GENERAL SURGERY

- NELSON M. PERCY and OSCAR E. NADRAU—g. Operative
 and dry clinics.

Wednesday

GENERAL SURGERY

- A. T. LUDGREN and EARL GARNER—g. Operath and dry
 clinics.
 JERRY W. NUTCH and RUDOLPH ODER—g. Operath and
 dry clinics.

Thursday

GENERAL SURGERY

- NELSON M. PERCY and OSCAR E. NADRAU—g. Operath
 and dry clinics.

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